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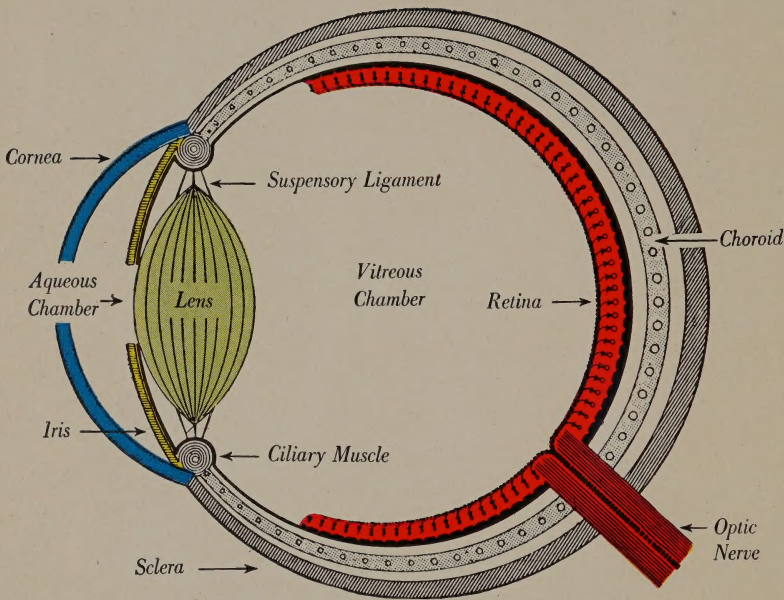
Your Eyes



Diagrammatic schema of the normal human eye

Your EYES

BY

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FIRST EDITION

To the memory of my late teacher

WEBB WILLIAM WEEKS, M.D.

who would have smiled quietly & approved

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TO

THE READER

LONG ago, before the days of scientific medicine, the patient-doctor relationship was a simple one. The patient furnished the ailment, and the doctor did his ignorant best to cure it. Frequently he was unsuccessful.

So little was known about the cause and cure of disease in earlier days that when the patient did get well, credit was often given to the supernatural. That pious old surgeon, Ambroise Paré, was fond of saying: "I dressed him and God cured him." The Almighty thus became the most important factor in the business of curing disease, the patient the least. Somewhere in between was the doctor. This is written in all due reverence. We still have miraculous recoveries in medicine which, with all our knowledge, are hard to explain.

By the beginning of the twentieth century the rôles had shifted somewhat. The deity now had a right to expect a good deal more help from the modern physician than from the military surgeon of the sixteenth century. And more recently the importance of the patient has also been recognized. Medicine now realizes that he is much more than the passive vessel of diseases; much more than an abstract problem in diagnosis and therapy.

During the long process of evolution from the ancient medicine man to the modern medical man we have learned that the more the patient knows about himself and his ills the easier the work of the doctor becomes in preventing and curing disease. In other words, the more the patient becomes a true partner in the patient-doctor combination the less is the load the physician has to carry. The full significance of the word "doctor," derived directly from the Latin "teacher," is at last coming into its own. Hence the modern accent on medical education for the layman. And hence the justification for this volume — if it needs justification.

The average man knows so little about his eyes! It may be professional bias, but offhand I can think of nothing of as great immediate importance to man about which he knows less. Many who have been wearing glasses for years do not know whether they are nearsighted or farsighted. Do you? And then there is the constant "What is *astigmatism, doctor?"*

Much of the little that the average man knows about his eyes is hearsay. Often it is misinformation gleaned from sources more interested in selling a product than in disseminating accurate facts. The patient is entitled to more than this. He wants more than this, judging from questions constantly asked in office and clinic. I have attempted to answer some of these questions.

There is little here that is new. Most of this has been said over and over again in textbooks and periodicals devoted to the eye. But the average man — fortunately for him, perhaps — does not read the medical literature. I have therefore tried

to lay before the reader the commonly accepted facts that he ought to know about the eye.

In a book of this sort it is manifestly impossible to do more than touch – lightly – on a few of the more important topics. I have done this, I think, without recourse to esoteric medical terms or scientific mumbo-jumbo. On the other hand, no attempt has been made to "write down" to the grade-school level. I have assumed that the average individual intelligent enough to want to read about his eyes would not want the material predigested.

I am indebted to the National Safety Council, and particularly to Mr. J. S. Baker, for assistance with data on traffic and traffic regulations; and to Mr. H. Slobin of the New York City Transit System for facts on indoor lighting. I also wish to thank the editors of The American Mercury *and of* Coronet *for permission to use material previously published.*

S. A. F.

Your Eyes

I

"The Light of the Body"

We live by sight.

Of the five senses, vision alone is responsible for more than four-fifths of our awareness of things around us. A sharp noise, an unusual smell, a strange touch – and immediately our eyes look for the source. We must *see.*

We work, play, love, hate, and talk with our eyes. With mouths shut tight we can threaten and caress, arouse and subdue, invite and repel, scorch and freeze – with a glance.

We can see in countless different ways, and our language is rich in words to describe this infinite variety of vision: We look, observe, behold, discern, descry, perceive, notice, gaze, scan, scrutinize, stare, glare, peer, leer, eye, spy, etc., etc.

But let us not labor the point. Most of us are quite aware of the importance of our eyes and do not have to be sold on the proposition. We may not have realized how intimately they are bound up with all our waking life and actions, but as far back as we can trace the records of man vision has been the most cherished of his possessions, next to life itself. Many are even more positive and consider life without vision valueless.

Indeed, about 4,000 years ago, long before the age of medical specialization, in the Babylonian Code of Hammurabi we find references to the eye physician and proof of the high value that people, even in that rough and tough civilization, placed on the eye. The eye surgeon of those days – the first medical specialist in history – had to be mighty careful. Those old boys did not mince words:

"If a physician open an abscess in the eye of a man with a bronze lancet and save that man's eye, he shall receive ten shekels of silver as his fee; if it be a freeman (freed slave), he

shall receive five shekels; and, if it be a man's slave, the owner of the slave shall give two shekels of silver to the physician." But ". . . if a physician operate on a man and cause the man's death; or with a bronze lancet, open an abscess in the eye of a man and destroy the man's eye, they shall cut off his fingers." If it was only a slave's life or eye, the physician had to pay half the slave's market value to the owner.

Not only is the Code illuminating as a commentary on the social order of the day, but it also shows clearly that the eye and life were held in equal esteem, even in those benighted days. Evidently eye practice long ago was not entirely free from hazard to life and limb. And Heaven help the unskillful or unlucky wielder of a bronze lancet!

Incidentally, it may interest some of our modern jokesters to know that old King Hammurabi, who ruled somewhere around 2000 B.C., also laid down a course of treatment for ailing eyes in his Code and that the prescriptions varied according to whether the right or the left eye was involved.

The eye has always been a source of intense interest to human beings, and many myths have grown up around it. Not so many years ago the "evil eye" was considered a definite entity whose baneful influence was to be avoided as the plague. The effects on the recipient of its attentions are highly questionable, but the danger to its hapless owner was very real, judging by the tales that history has to tell.

We know now — most of us — that the "evil eye" of our forebears was only a mote in their own ignorant eye. We do not condone their cruel superstitions, but we can understand them. For, though we have come far along the road leading away from those days, in the course of our journey we have acquired some misconceptions and myths of our own about the eye.

We are all born blind, blue-eyed, and free of illusions; but we do not remain so long. In the first few days of life we learn how to see. Most eyes soon change their color from blue to brown. And before many years have passed we acquire eye troubles, misapprehensions, and glasses. If the oldsters looked with horror on the imaginary "evil eye," what would they

have done at their first glimpse of our much-too-real bespectacled and begoggled eyes? There are many glass-wearers today – and not only women – who feel that we have not gained much in our evolution from the primeval slough.

Why do so many of us need glasses? Is the need for them greater now than it was a thousand years ago? Are our eyes becoming worse? Or does it seem so because we have better means of diagnosing eye infirmities today? If more need glasses, why do they not wear them? The answers are not always easy.

We start from scratch with the best visual apparatus in the animal kingdom. It used to be the fashion to compare our eye to a camera. We know better than that now. It is a far more efficient, labile, and useful instrument than any conceived by man.

With it we make photographs on a sensitive retinal negative under extremes of light and shade where the most expensive camera would be useless. We change our focus automatically and instantaneously for distance and for near. We not only see better than most animals – yes, even better than a cat in the dark – but our eye helps us to convey expression and emotion. We cry with it, which helps distinguish us from the lower species. With it we recognize the finest gradations of color. Our field of vision is wider than that of any other living thing. And that is not all.

We may not be quite so farsighted as the eagle or so quick to detect infinitesimal movements as the deer or rabbit, but we have something far, far more valuable. Our versatile little visual organs give us not only enough of the bird's distant vision and the beast's motion-detecting ability to serve all our needs, but in addition we can see near objects as clearly as distant objects. Few other animals can do that. The page you see before you would be nothing but a blur to most of the lower species.

We are superior to them, too, because we see the same objects with both eyes. Only the highest in the scale of evolution have this gift. Thus, simple-minded Adam, less wise than the serpent, still possessed the advantage of having eyes in the

front of his head and not at the side. The importance of this cannot be overestimated.

Because of the position of our eyes, single binocular vision has reached its highest development in man. This means that when we look at a white object with a red glass placed in front of one eye, we see neither a lively red nor a dead white; the two are fused into a placid pink. This also means that we have depth and distance perception, because each eye views the same object at the same time from a slightly different angle. By long experience our brain has learned to fuse these two images into one composite having the elements of thickness, relative size, and perspective.

Animals with eyes at the side of the head do not have this. Their right eye knoweth not what their left eye seeth. Theirs is a flat, two-dimensional world. It must be an uninteresting existence. A child who is born blind in one eye or who loses the sight of one eye before he can store up sufficient visual experiences has this kind of flat vision. He may become a great physician, writer, or musician, but never a painter or – what is more serious – a good shortstop. For most of us, however, the function of the two eyes is so well fused that to all intents and purposes they act as one centrally located cyclopean eye.

Then what has happened to this remarkably efficient and versatile visual equipment of ours? Why should anywhere near two-thirds of us need artificial assistance to see clearly? Nature is not doing well by us today, or perhaps we are not doing well by nature. The trouble may be that our eyes have not yet caught up with our new method of living; that we have not yet quite succeeded in "civilizing" them.

Apparently, the more enlightened we become the less we see. Modern civilization has beaten plowshares into desks, has substituted the poorly lighted office and shop for the great outdoors, and has traded us soft white hands for the better vision of our tree-living ancestors. At least, the more exacting demands we make of our visual apparatus have brought out weaknesses which would have passed unnoticed in the pre-industrial age.

Visually speaking, we have been cheated in our descent

from the treetops. We have taken our outdoor-loving and -living eyes, adapted to sunlight as great as 10,000 foot-candles, and have imprisoned them in dark cubicles where the light is usually less than 10 foot-candles. Perhaps we should be thankful that many of us still see as well as we do and that so many of us still have excellent eyes.

In order to answer intelligently some of the questions that we have raised we shall have to know something about the structure of the eye and how it functions. This will enable us to understand the factors that interfere with our ability to use our eyes efficiently and comfortably and to discuss how best to overcome these factors.

II

How We See

The act of seeing implies a good deal more than the reaction of a sensitive tissue to light.

The silver emulsion of the camera film responds to light by making a picture. Flowers respond to light by growing toward the sun. Some minute organisms such as the amœba shy away from the light; others are attracted to it. These are all reactions to light.

The earthworm has a collection of sensitive cells called an eye-speck which makes it react to light by hastily crawling back to its burrow at the first peep of dawn. This is a specialized organ which reacts to light; but this does not mean *seeing*. A push or an electric shock would make the worm do the same thing.

In similar fashion a shadow cast by a fish on the prowl will cause barnacles to close and loose oysters to dig deep into the mud. They react to light, but do not know why. All they know is that something in their environment has changed, and they sense danger.

Even the insects with their thousand-faceted compound eyes do not *see* in our sense of the word, because they haven't our highly developed brain to interpret the sensation of light to them. It is only when we come to the higher vertebrate or backboned animals – from the fish upward – that we have a visual organ that sees as you and I understand seeing.

In such animals, including man, the eye is not only connected with the brain, but it is literally part of it. During the developmental stages of the embryo in the uterus a part of what is to become the brain is pinched off and converted into the specialized sensory organ that we call the eye. And it al-

ways remains connected with the brain by a long thin cable, the optic nerve.

The brain, acting as a central receiving station, registers the message received along the optic nerve, interprets it, and relays it to the rest of the body. Then, if necessary, we do something about it. Thus a sudden flash of light will make us jump, even if there is no sound, because the brain has telegraphed its message to the legs and we have heeded the warning.

So it is our eye that initiates the process of seeing, but it is its connection with the brain that distinguishes our vision from that of the lower animals. St. Anthony's cheering comment to blind Didymus, the great third-century theologian, that vision was only something "which we possess in common with the gnats and the ants" was the graceful act of a great-hearted man, but not very good physiology. There is little in common.

It is even possible for us to feel a luminous sensation without light. Sudden pressure on the closed eyeball, an electric current or a good punch in the eye, will make us "see stars" because the eye, stimulated, can respond in only one way — by seeing. But, of course, the most common stimulus we have is light itself.

In the final analysis our vision is based on two indispensable factors: light and the eye. At the height of the noonday sun no vision is possible without eyes, and no living animal, including the cat, can see in absolute darkness.

The eye is a round little body about an inch in diameter, a bit longer from front to back than from side to side. It lies well buried in a depression of the skull, the eye socket. And it is connected to its surroundings by folds of tissue, the external eye muscles, nerves, and blood vessels.

Even in its exposed portion it is well protected. The overhanging brow shields it above; thus, the more beetling the brow, the better. The nose and the cheekbones guard it at each side and below. The lids in front shut instantly at the first hint of trouble, and the tear gland is constantly supplying an antiseptic fluid to keep the eye fresh and moist. It rests

on a cushion of fatty tissue that makes its movements wonderfully easy and helps give it resiliency to absorb shocks.

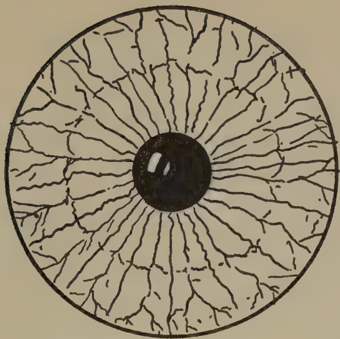
In the front of the eye is a round transparent window, called the cornea, plentifully supplied with sensitive nerves. Anyone who has had a cinder stuck to it can vouch for that.

Behind the cornea and separated from it by a layer of transparent fluid, the aqueous humor, is the iris. This is the membrane that gives the brown or blue or gray color to the eye. It corresponds to the shutter of a camera, but, unlike the camera shutter, it acts automatically by contracting in bright light and dilating in dim illumination. It requires no setting. The pupil, the black spot you see in the center of the eye, is merely a round opening in the iris, like the hole in the doughnut. It looks black because the interior of the eye is dark.

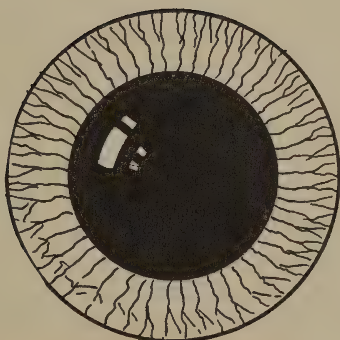
Directly behind the iris is the transparent crystalline lens held in place by a diaphanous suspensory ligament attached to the inner circumference of the eye. It is to this little structure that we owe our ability to look from distance to near and back again without giving it a thought. It is by means of this crystalline lens that the focus of our eyes is constantly changed. "Accommodation" is the technical term.

The lens is also surrounded by a tiny muscle, the ciliary muscle, which helps us to do this accommodating. When we look at a distant object the lens is rather flat from front to back and looks like a small lentil standing on edge (hence its name?). As we look at a near object the ciliary muscle allows the elastic lens to relax, and it becomes more spherical. As a result the focusing power of the eye is increased, and we are enabled to see near objects distinctly. And this, mind you, happens in every normal eye smoothly and instantly without adjustments or gadgets.

Without the lens we should be no better off than those lower animals we spoke of which only see light, because we should be unable to focus clearly. Those who have had cataracts removed (a cataract is simply a lens that has become cloudy) have just this kind of vision, and to see clearly they need an artificial lens in front of the eye to make up for the one removed.



The pupil in bright light



The pupil in the dark

Behind the lens and filling the greater bulk of the eye is a jellylike transparent material, the vitreous humor, which helps the eye to keep its normal shape and pressure and makes it sufficiently elastic to "give" when it is accidentally struck.

The inside of the eye is lined, except in front, by the retina. This is an exceedingly thin membrane, composed of percipient nerve elements, which is directly connected with the live-wire fibers of the optic nerve and so with the brain. This fine membrane is the most important part of the eye.

The whole mechanism is encased in an envelope of tough white tissue, called the sclera, which is the eye's inner wall of defense and through which course the nerves and blood vessels which nourish the eye and keep up its efficiency.

We have therefore in the eye all the four necessary elements of the camera. The cornea-lens combination corresponds to the focusing lens, the iris to the shutter, the vitreous chamber to the dark chamber of the camera, and the retina to the film. Also, just as light must pass through the camera and hit the film in the back in order to make a picture, so must light, which is a form of energy, pass through the cornea, aqueous, pupil, lens, and vitreous – i.e., from the front of the eyeball through its whole length and clear to the back – before it can strike the retina and be converted into a nerve stimulus. The latter, in turn, is received by the visual centers in the brain and becomes a visual sensation.

And it might as well be stated right here that, contrary to popular opinion, it is impossible to take an eye out of its socket and put it back again; or to replace one eye with another and still maintain vision. It must be obvious that, once the many nervous and vascular connections between eye and brain are severed, they can never be united again. Some day, perhaps, but not yet.

The retina, the most important agency for the transmutation of light into sight, deserves a little more explanation. As a matter of fact, the real function of the whole eyeball is to give support to and feed the retina so that it is always in condition to perform its job properly; just as the main function

of the camera is to furnish a means for focusing light properly on the film.

We have seen that the eye does much more than just see light. It is able to perceive the size and shape and intricate details of objects. It is able to distinguish colors in all their many tints and shades. We can tell whether an object is stationary or in motion. And we can see in bright sunlight and in deep twilight. Most of us have not thought about it very much; we have simply taken our many kinds of vision for granted. But in order to be able to do all these many things specialization of the highest sort is required. It is all found in the retina.

By microscopic study it has been ascertained that there are two kinds of light receptors in the retina. One type, the "cones," is found mostly in the exact center of the back of the retina, richly crowded together into one small space called the macula lutea or yellow spot. This is the area of keenest vision of the retina and gives us our ability to make out fine details and the shapes, sizes, and colors of objects. It has been estimated that the average human retina contains about seven millions of these cones.

The other type of light receptors, called "rods" because of their relatively elongated shapes, is scattered over the rest of the retinal periphery. The rods are infinitely more sensitive to light than the cones, and they help us to detect motion and to see under conditions of poor illumination. We have about twenty times as many rods in the retina as we have cones.

Thus, while driving your car you can easily detect out of the corner of your eye (rod vision) that someone is alongside of you. But in order to determine whether it is just another car or a guardian of the law you have to turn your eyes so that your central (cone) vision may give you the details of size, shape, and color.

In strong light the pupil automatically contracts to keep out excess light. This also helps to collect the light and focus it on the central macula, thus giving us good visual definition. In the twilight or in a darkened room the pupil dilates so that more light can get into the eye, and the peripheral rods are

called into action. Hence it is the central cones that are the important factor in daylight vision and bright illumination, and the peripheral rods that are chiefly responsible for twilight or night vision.

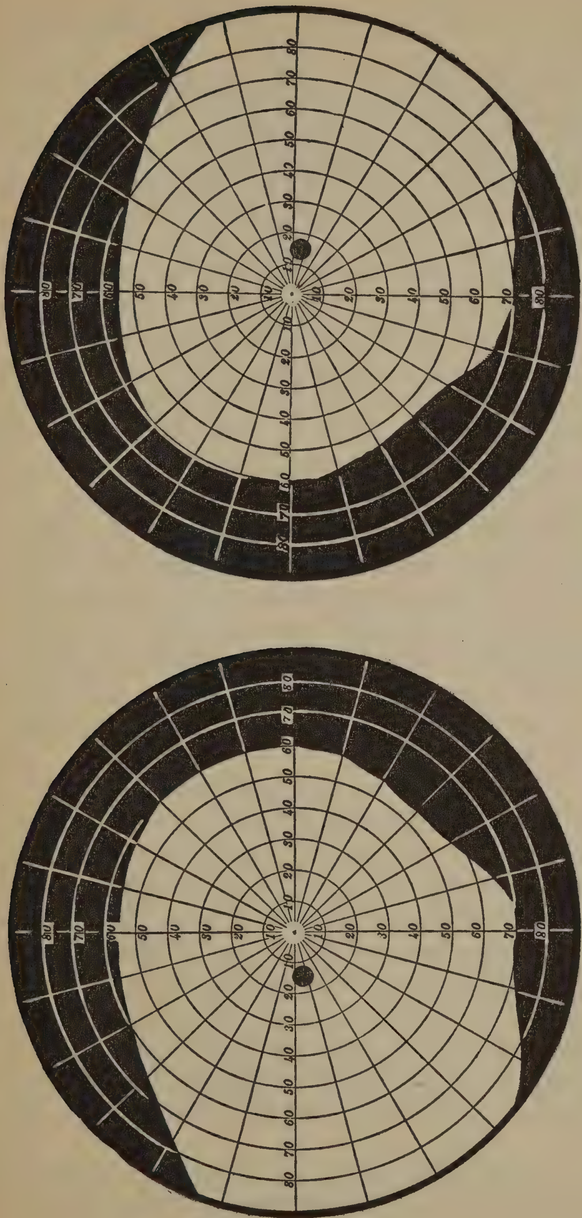
The remarkable qualities of this retinal mechanism can be appreciated only when we realize that the average normal eye has the ability to increase its efficiency a millionfold. With contracted pupil the eye can see in the bright glare of the noonday sun. It can also see clearly in the gloom of dusk. This is brought about by the dilatation of the pupil and a tremendous increase in the sensitivity of the retina.

To prove to yourself that it is the peripheral portion of the retina that takes over the job of seeing at night or in the dark, try this little experiment. Some dark night pick out a star and look at it directly for a moment, then shift your gaze a little to the side of it. Be sure that you pick a good dark place for your star-gazing. You will note how much brighter the star looks when you do not look directly at it; for then you are using the peripheral portion of your retina and not the central macula.

Modern scientific warfare, not overlooking this important factor in night vision, has drafted it right into service. Proper use of the eyes at night is a regular part of the training curriculum of fighting men. Thus soldiers, sailors, plane and tank spotters are taught not to look directly at suspicious lights and objects at night, but out of the "tail of the eye," first to one side and then the other. No wonder Arago, the famous French astronomer, said: "In order to perceive a very dimly lighted object it is necessary not to look at it."

In a good light, however, the acuteness of vision falls off rapidly as we go from the center of the retina to the periphery. If, while reading this line, you look at the central word, it will be clear, but you will note that the words to each side are hazy, and the nearer the words are to the ends of the line the more indistinguishable they are.

It is the rods which contain the visual purple or rhodopsin, which, despite its colorful name, has nothing to do with color vision. Lack of this is responsible for many of our cases of



RIGHT EYE

LEFT EYE

The normal field of vision of each eye separately when looking straight ahead. Note the small blind spot in each eye a little to the outside and below center.

night blindness. More will be said on this subject later (Chapter X).

There is one area in the retina which, even in the healthiest eye, has no visual perception at all: the so-called blind spot. This is the point where the optic nerve enters the back of the eye, and it is easily demonstrated. Make two good-sized dots on a piece of white paper an inch apart. Close your left eye and look at the left-hand dot with the right eye. Now move the paper to and from you slowly. You will find a place where the right-hand dot disappears. At this point the image of the dot falls on the blind spot of the retina and is not seen.

There are many other fascinating facts to be told about the retina. For instance, there is the persistence of visual impressions that makes the movies possible. This depends on the fact that the images falling on the retina are not instantly obliterated, but persist from one-fiftieth to one-thirtieth of a second after the object looked at has disappeared. As a result the action on the movie screen does not appear as a broken series of "stills" but as one continuous motion, because the image of one scene does not fade from the retina before another has taken its place. Owing to this faculty a light flashed at the rate of fifty times a second would appear stationary. When the eye is tired, thirty-five or forty flashes are enough to make a blinking light look steady.

Nor need it concern us that we "see things upside down." It is true that the image on the retina is inverted, just as it is on the camera film. But our own experiences and our brain help us to set it right again. Several years ago a series of experiments were performed in which the subjects wore prisms before their eyes which gave them an upright instead of inverted image on the retina. At first they were helpless and went around stumbling into things. But after a while they became adjusted to their new environment and got along normally. When the prisms were removed they had to go through another period of readjustment before objects came right side up again.

Also, most of us are right-eyed as well as right-handed. This dextral dominance of the eye is less obvious than that of the

hand because we normally use both eyes at the same time. But in aiming a gun, sighting along a line, or looking through a spyglass the right eye is the one most commonly used. A few left-eyed individuals prefer to lead with the left eye.

There are many other important facts about the function of the eye that we should know. These will be discussed in their proper place in subsequent chapters.

III

Why We Do Not See Well

The average man of forty who is five feet eight inches tall weighs 159 pounds and sees 20/20. But many of us do not conform to these averages either in stature or visual ability.

The mysterious fraction 20/20, used as the standard of vision, means that at 20 feet away from the eye-testing chart the person examined is able to read letters of a definite size designed for that distance. If the vision is 20/30, then at 20 feet he can only read that size letter which he should be able to read 30 feet away. In other words, the numerator of the fraction designates the distance from the chart to the eye being examined; the denominator the size of the letter which the eye is able to read at that distance. This standard was designed by a man named Snellen in 1862, and the Snellen chart or its equivalent is still commonly used for testing vision.

In reality 20/20 is not "normal" vision in the sense that every eye that does not see 20/20 is not normal. It is *average* vision. There are some who, even with the best corrective glasses, can see only 20/30, though nothing wrong can be found with their eyes. Others can see 20/15. In either case this does not mean that these eyes are abnormal. It only means that the normal for these particular eyes is either a little worse or a little better than the average. The comparison with average height and weight is obvious and apt. There are many short and thin or tall and stout individuals who would indignantly — and justifiably so — resent being called abnormal.

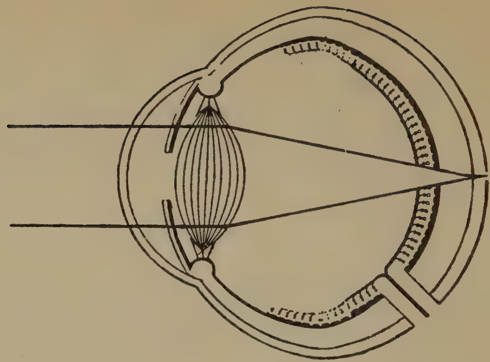
And just as our bodies vary normally in length and curvature, so do our eyes. It is these differences in dimensions of the eye that give us our most common refractive errors, i.e., hypermetropia (farsightedness), myopia (near sightedness), and astigmatism.

We have seen that the normal eye is so adjusted that light coming into it is focused exactly on the center of the retina. Now, it may sound paradoxical, but the trouble with the farsighted eye is that it is too short, and with the nearsighted eye that it is too long — too short and too long, that is, measured from front to back. Where the average farsighted eye measures less than the inch of the normal eye, the nearsighted eye measures more than an inch from cornea to retina. In consequence light coming into the short farsighted eye is focused *behind* the retina, while the long nearsighted eye focuses light *in front* of the retina. In both cases the result is poor vision. And the difference either way does not have to be great to play havoc with our ability to see.

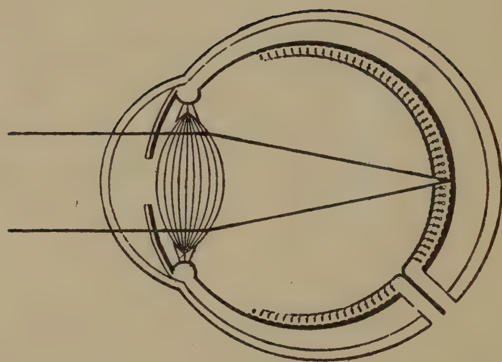
Since at birth the eye is only about two-thirds of its adult size, the short eye may sometimes catch up by growing a little faster than its surrounding socket and may become less farsighted, or even nearsighted, by the time it has attained its full size at the age of nine or ten. This occasionally happens to children. Most farsighted eyes, though, remain farsighted permanently. This is especially true where there is retarded growth of the eyeball, which gives a very high hypermetropia.

Farsightedness is the most common of our refractive difficulties, and yet it was the last to be clearly understood. Not until Franz Donders, a Dutch ophthalmologist, defined this condition clearly in 1858 did we fully appreciate the how and the why of farsightedness. He named it "hypermetropia," i.e. over-sightedness or too-much-sightedness. It is estimated that about 50 per cent of all adults have it.

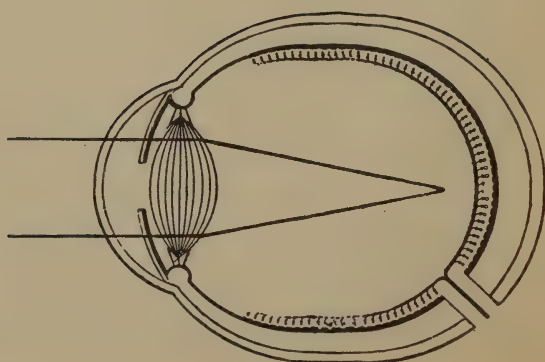
Along with most other animals, we are born farsighted, with eyes adapted to distant vision and wide-open spaces. Most of us remain that way. But, unlike the wild animal, we in the captivity of civilization usually carry on our activities and do our work at close range. For several hundred years now we have been forcing our naturally farseeing eyes to do work just under our noses — literally. It is not at all remarkable that many farsighted people should need glasses for near work. Nor is it remarkable that doctors and lawyers should



The farsighted eye



The normal eye



The nearsighted eye

have more eye troubles than farmers, and bookkeepers more than truck-drivers.

Which brings us to one of the most common of eye fallacies: that the farther you can see the better your eyesight. Actually, good distant vision does not always mean efficient eyesight. If you could read every character, even the tiniest, on the vision test-card, it would still be no indication that your eyes are normal. As a matter of fact the more farsighted the individual the more trouble he has seeing things near him clearly. For the farsighted eye is like a camera eternally focused on the distant horizon – a camera whose photographs of near details are blurred and indistinguishable. This puts some of our eagle-eyed friends at a great disadvantage.

In order to overcome this difficulty we have the lens mechanism described in the previous chapter. But since the farsighted person has to keep making this adjustment for clear vision constantly, he is more likely to have difficulty than his nearsighted neighbor. And this is the most common cause of the train of symptoms – including headache, blurring of vision, itching and burning of the eye, etc., etc. – to which we have given the rather vague name "eyestrain."

Some eyes are farsighted to such a degree that the very word becomes a misnomer. Such an eye is focused for a point so distant (it may be described as infinity) that the ciliary muscle-lens mechanism cannot possibly correct the vision to normalcy. Such eyes are almost as bad as nearsighted eyes for ordinary distances. And they have the additional disadvantage of not being able to see near at all, as the nearsighted person usually can.

Farsighted individuals are frequently condemned to eye discomfort for the crime of seeing too far unless adequate examinations are made and the fault corrected with proper glasses.

Another major eye defect is myopia or nearsightedness. While myopia in the newborn is the rare exception, it is found in over 10 per cent of children in the primary grades; and be-

tween the ages of ten and twenty it has increased to about 20 per cent.

Back in 1604 Johann Kepler, a German astronomer, explained the optical principles of the myopic eye. It was thus the first of the refractive errors to be known, but it is still the least understood. For since that time we have been trying to find out why we should have such an eye — optical principles and all. So far we have had little success.

Many explanations have been offered. Their very multiplicity mirrors our lack of knowledge. Some will tell you that myopia is due to heads that are too long from front to back (dolichocephalia), causing a concomitant stretching of the eyeball and a consequent myopia. Others say that it is due to the head being too wide from side to side (brachycephalia), necessitating an excessive convergence for near vision and hence again causing a consequent stretching of the eyeball. The proponents of the latter theory point in triumph to the many nearsighted Germans and Orientals, with their wide faces. And it is a fact that about 50 per cent of the young children in Chinese schools, for instance, are myopic as compared with approximately 10 per cent here.

The only trouble with this theory is that many narrow-faced individuals cannot see a foot ahead of them without their thick myopic lenses. Nor does this explain the cases of myopia in which the eye is normal in length but in which the curvature of the cornea or lens is greater than normal, thus increasing the focusing power of the eye and making it myopic in spite of its normal length.

Another theory is that in our reversion from the feral to domesticity our eyes are becoming nearsighted at a gradual but steadily increasing rate. And it may be that our eyes are trying to adapt themselves to our new method of living and — as frequently happens in nature — are going too far. Sir John H. Parsons, one of the outstanding English ophthalmologists, believes that the biological normal in man is shifting from farsightedness to nearsightedness and that a permanent degree of low myopia is not pathological and is no more indicative of a "sick" eye than an equal degree of farsightedness. Thus

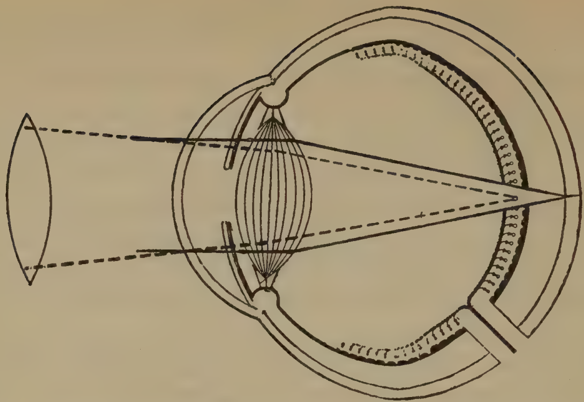
one may consider that myopia is a developmental condition, i.e. one of several refractive types, and that a person may be hypermetropic or myopic just as he may be tall or short, blond or brunet.

Poor light, poor posture, lack of proper glasses, acquired diseases, hormone, vitamin, and mineral deficiencies in the diet, the mechanical pull of gravity due to excessive stooping, and too much use of the eyes for prolonged near work have all been blamed. In short, the exact cause of nearsightedness is unknown. Perhaps some, perhaps all the above factors are partially responsible.

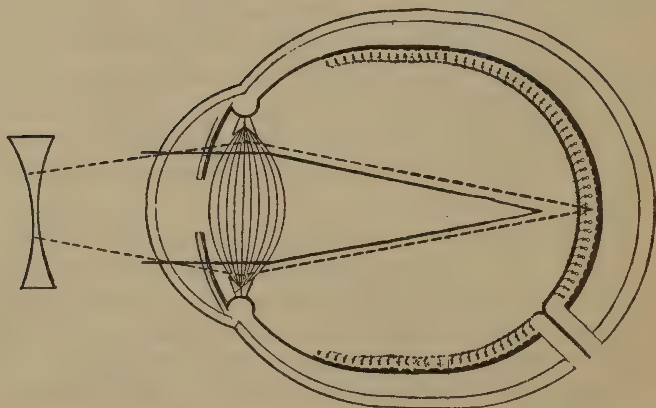
We do know that increasing myopia is most commonly found in children during the early school years. But why it increases in some cases and not in others is what we still cannot explain. We also know that there is usually a tendency for myopia to progress up to the eighteenth or twentieth year and then to remain stationary. Most certain of all is the fact that the surest way to become nearsighted is to choose nearsighted parents. The hereditary tendency here is a strong one.

By comparison with the headache and eyestrain commonly found in the farsighted individual the problem of the nearsighted one is usually simple. He just does not see well. To go back to our simile of the camera, the nearsighted eye is permanently focused for near objects, and the more nearsighted the eye the shorter the focus and the less clearly are distant objects seen.

The farsighted eye may improve its near vision by accommodating, but the nearsighted eye cannot improve its focus for distance unaided. Thus the myope or nearsighted person sees near objects clearly — he usually has no trouble in reading or writing — but a short distance from him is a world permanently obscured unless he wears proper glasses. His bad luck lies in the fact that, once having become myopic, he remains so to the end of his days. He never grows out of it. For myopia is an irreversible physiological process. Neither time nor glasses nor the surgeon's skill can change that in the present stage of our knowledge. If you are nearsighted, you may wear glasses for twenty years, and when you take them off



In the farsighted eye light rays are focused behind *the retina (unbroken line). Converging lenses are therefore prescribed to bend the rays toward the retina (broken line).*



The nearsighted eye is too long, and light is focused in front *of the retina (unbroken line). Glasses to diverge the rays and focus them on the retina (broken line) are therefore prescribed.*

you will still be as nearsighted as ever. The only possible change is more myopia; and this sometimes happens despite all the preventive measures adopted.

Thus, loving parents who wait for the day when little nearsighted Mary can throw away her thick glasses and meet the world unencumbered by these unsightly cosmetic detriments are waiting for the millennium. That day will never come. Didn't the neighbor next door say that her vision would improve as she grew older? The truth of the matter — and this, I know, is a bitter, unpleasant truth to many mothers — is that nearsighted children always remain so. A good deal of twaddle on this subject, spread mostly by irresponsibles, is prevalent, and it causes many an unnecessary heartache. The nearsighted child lives in the center of a much more closely encircled world than the child with normal eyes, and it deserves early and competent assistance if it is not to be handicapped in this highly competitive age.

There are a few myopes who, even with low degrees of refractive error, suffer from eyestrain without their glasses. For one thing the myope usually has a larger pupil than the hyperope, and hence more light gets into the former's eye, so that he is more likely to be annoyed by strong light and glare.

Again, because of this larger pupil and consequent excess light, the nearsighted person tends to squeeze his lids together in an effort to shut out these peripheral rays and obtain clearer vision. This pressure may also flatten the eyeball a little and make it less myopic, thus giving better distant vision. We have all seen the nearsighted person "squinting" his or her eyes in order to see more distinctly.

As a matter of fact most of us with refractive errors have better distant vision when we shut out all peripheral light rays. Try it yourself by taking your glasses off and looking at some object through a pinhole in a piece of paper. It is just about as clear as if you were wearing your glasses; or even clearer if the glasses are not properly fitted. The myope gets this same kind of anatomic pinhole by screwing up his eyes until they are almost shut. And he needs it much more than the others because of his relatively larger pupil.

Also, the myopic eye is often complicated by astigmatism. And this is another factor making for headache and eyestrain. Another possible reason is that the myope has to hold things closer to his eyes than the average person. This puts a strain on the muscles which converge our eyes, and this also may give a sense of fatigue.

There is a progressive or malignant type of myopia which goes on increasing despite anything we can do. The problem here is a difficult one. There is a great temptation to advise such a person to stop using the eyes. But this is not always possible; such people must earn a living like the rest of us, and a common-sense attitude must be adopted. Nor, indeed, is there any certain evidence that restricted use of the eyes will halt the process. Fortunately this is not a common condition, though it occurs often enough to add a few gray hairs to the eye physician's head. Such cases, even more than any other type of refractive error, require a complete medical examination and should be under the care of a physician constantly.

Many cures have been suggested for myopia. These are based on the various theories of its causation. The ingestion of various minerals, vitamins, and hormones, the installation of all kinds of drops, also all kinds of exercises, have been suggested. The effect of many of these is questionable; some are worth trying. Doctors agree that a full correction of the vision with glasses, a proper diet, training in proper posture, frequent examinations, encouragement of outdoor exercise, restriction of near work to the necessary minimum, and proper attention to lighting, at least during the growing years, constitute the proper basis for treatment. This is not always successful in arresting the progress of the condition, but there are many cases in which good has been derived from such measures.

The general opinion among physicians now is that myopia is not the fearful thing it was once thought to be. It may even be an advantage in some cases. There are many occupations such as fine needlework, engraving, jewel-setting, watchmaking, etc., which require very close application of the eyes and at which the moderate myope with his excellent near

vision is better off than his farsighted confrère. Nor do such people, once their myopia has become stationary, seem to suffer as a result of this near work. We must, therefore, distinguish between the so-called developmental myopia and the relatively rarer progressive myopia. I know of one outstanding ophthalmologist, not nearsighted, who wishes he were, so that he would not be bothered with glasses every time he wants to read something.

So the adult with a moderate amount of myopia who has good vision with his glasses – and this description fits most myopics – should not feel at a disadvantage or think himself a freak. Many are in the same boat with him – all doing well. He might also derive some comfort from the fact that medical science is gradually changing its mind about him and is beginning to classify him as a developmental type and not as a pathologic freak.

In passing it might be stated here that the size of the eye has no relation to its visual ability. The big saucerlike orbs above Eddie Cantor's nose probably see no more of the world than the relatively smaller mirrors of the soul that peer at you from over Jimmy Durante's proboscis. As a matter of fact, in some cases of nearsightedness the eyes tend to protrude and appear larger.

As if farsightedness and nearsightedness were not enough, we also have astigmatism to plague us. Rare indeed is the patient who sometime during the course of an eye examination does not ask "What is astigmatism?" Meaning literally pointless or not clear, it is just that to many eyes and individuals. Roughly, it is an unequal curvature of the refracting surfaces of the eye – the cornea or the lens, usually the former. In a camera it would mean that the focusing lens is so ground that it is curved more in one direction than another. As a result, rays of light are focused not as clear points, but as blurs. It is the most common and annoying of all abnormalities. Yet "abnormalities" is not the precise word, because the majority of people are astigmatic. Fortunately their astigmatism is not always severe enough to cause trouble. While it may be pres-

ent alone, more frequently it complicates the life of the nearsighted and farsighted. Such an eye can be corrected with glasses, but astigmatism, like hyperopia and myopia, is incurable.

Astigmatism was discovered in 1793 by Thomas Young, long before farsightedness was explained. It was not until 1826 that McAllister, a Philadelphia optician, ground the first lens to correct it. Many of us owe him a debt of gratitude.

The tendency is for astigmatism to remain more or less constant until middle age or beyond. Then it tends to change and increase. Though minor astigmatic errors may be ignored in youth, they frequently cause more severe eyestrain than larger errors of refraction. For, if the error is too large, the eye may give up the struggle and simply let it go at poorer vision. But in the case of the smaller errors the eye, constantly trying to overcome the handicap, may become severely fatigued in the process. Hence from the point of view of comfort the poorer seeing eye may sometimes be better off than the eye with better vision.

All of us as we get older lose our youthful resiliency and put our eyes to more and more use in office, study, and shop. Then we begin to find that we need help. This is especially true of the "nervous," high-strung type of person. Many a robust, placid, phlegmatic individual with a high amount of astigmatism seems to have no trouble, whereas another with only a fraction of the former's refractive error is lost without his glasses. It has been estimated that astigmatism combined with hyperopia or myopia causes three-quarters of the functional headaches due to close work.

Aniseikonia is a condition long known to the eye physician but only recently legitimized by being christened. It is a rather unusual finding in which the size and shape of the images of the two eyes thrown on the retina vary. There are probably many in whom this condition exists. But most of us are able to overcome this through long experience and can fuse the slightly disparate images of the two eyes into one

composite perception successfully and with no attendant eye disturbance. In a few cases this fusion is not attained, or is attained only with difficulty, because the difference in the images is too great. The patient consequently suffers much the same symptoms as if he had one of the refractive errors or an eye muscle difficulty.

If all other remedial measures have failed, and especially if the covering of one eye for some time (thus barring the use of both eyes together) gives the patient relief, there is strong reason to believe that the trouble is binocular and probably due to aniseikonia. In such cases the patient should be examined by means of the eikonometer, an instrument that measures the difference in the image size of the two eyes. This instrument is now available in several of our large cities and will probably come to be more widely used as the need for it increases.

If aniseikonia is at the root of the trouble, the remedy is the prescription of special eikonic lenses in which not only the refractive correction, but also one for image size difference, has been incorporated. Aniseikonia is not too common, but where it is present it requires relief apparently not be be obtained in any other way.

Not all of the great men of science agree as to the efficiency of the human eye. Helmholtz, one of the greatest of German scientists, said: "The eye has every possible defect that can be found in an optical instrument and even some peculiar to itself. . . . If an optician tried to sell me an instrument which has all these defects, I should think myself justified in blaming his carelessness and sending him back his instrument."

On the other hand, Ernst Haeckel, the biologist, called the eye "the noblest organ in the body." But whoever is right and whatever its faults, we do not know how to make a better eye or duplicate a similar one. It would be fine if we could plant a seed and make an eye grow like an oak from an acorn. But these miracles still escape us. The Egyptians, they tell us, first made glass eyes to give their mummies a lifelike appear-

ance. We have perfected the glass eye so that it is practically indistinguishable from the living human eye. But we still do not know how to make people see with it. All we can do is try to correct with our relatively crude methods the faults that nature has given us.

IV

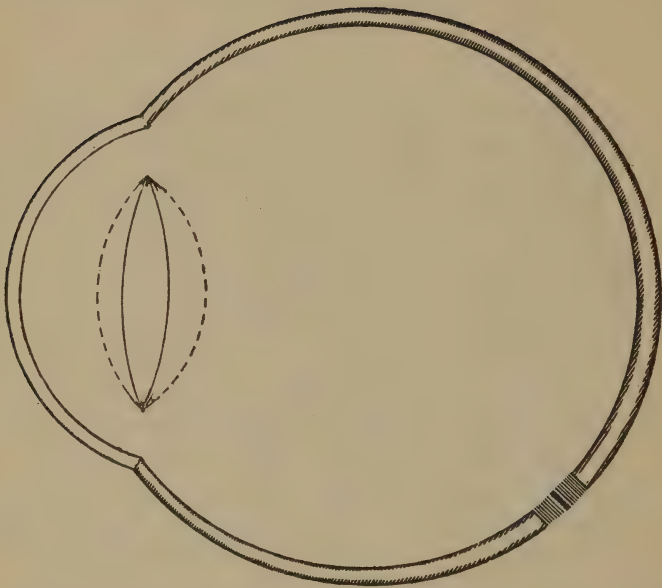
Old Sight

When we get to be around forty we all begin to need reading glasses; the farsighted sooner, the nearsighted later, all of us ultimately. We find increasing difficulty in seeing near objects clearly. We begin to hold our books and newspapers farther and farther away from the eyes and to need more and more light. "Old sight" or presbyopia is with us.

It may not be pleasant to inject this term of senility at a time when, in the modern phrase, life is just beginning. But I cannot stop the inevitable progress of the Old Man with the Scythe; neither can you. Contrary to popular belief, we do not become farsighted with old age; it is simply that our vision for near objects becomes worse. This is normal, has no relation to the general health, and is one of the important signs of the aging process – the same process which whitens and steals our hair and sends us to the dentist for artificial molars.

So that the coy young thing of the indefinite thirties who reads her book at arm's length is quite probably a decided forty-plus. She waits until her arms become too short and then seeks help for her eyes. A skillful masseuse may give her that schoolgirl complexion, but, like a horse's teeth, the eyes cannot lie about age.

And Father, who has been wearing glasses all his life, perhaps, finds himself grumbling about the same light by which he has been reading his paper for years. And he begins pushing his glasses down toward the end of his nose, because, although he may not know it, this increases the strength of the glasses for reading. If he has a good long nose, he may succeed in staving off the inevitable reading glasses for some time. But even the longest nose must end somewhere.



The lens focused for distance (unbroken line) and for near (broken line)

Our ability to "accommodate" or focus on near objects, as we have seen, is due to the lens inside our eyes, which, by changing its curvature so that it becomes rounder and hence of stronger focus, enables us to see near objects more clearly. Camera owners look with helpless longing at this automatic mechanism in our eye, and it is well worth the admiration.

As we attain adulthood, however, the elasticity of this lens is slowly lost. Gradually it becomes more and more rigid, and our ability to see close up becomes less and less. Hence the point at which we can read comfortably begins to recede from our eyes until, between the ages of forty and forty-five, we reach the stage where the lens of the eye can no longer do all the work, and we need a lens of glass to help us read and write comfortably.

This recession of the near point is a regular, measured process which, in the average eye, gives a definite idea of the age of the individual. It has been calculated that up to the age of forty the average individual with normal vision, or vision made normal with glasses, can read small print at a point near his eyes which is half his age in centimeters. Simply, this means that the ten-year-old child has the ability to hold fine print 5 centimeters (about 2 inches) from the eyes and see clearly. The thirty-year-old adult, on the other hand, can hold it no nearer than 15 centimeters (about 6 inches) from his eyes; closer than this, fine print would blur. These figures are of necessity variable, because the eye varies in capacity as much as the individual.

But after forty things begin to get away from us by leaps and bounds. Practically, this means that at forty-five you must hold a telephone book *at least* 11 or 12 inches from the eye in order to see clearly in good light. At fifty there must be at least 16 inches between you and the book for clear vision. At sixty you should theoretically be able to read a newspaper without glasses if it is 40 inches away. Actually, however, this is neither practical nor possible unless you are nearsighted. At sixty-five the machine has given out completely; there is no near point. Now you see why reading

glasses need changing at regular intervals until the age of sixty-five.

Nearsighted individuals have a distinct advantage here. It is obvious that the myope, with eyes normally focused for a distance nearer than that of the normal or farsighted eye, will arrive at the point where he needs reading glasses later in life; how much later depends on how nearsighted he is. Some persons, if sufficiently nearsighted, may never need them. For others it suffices merely to take off their distance correction. For the nearsighted person, you remember, wears glasses to correct eyes that see too near. By taking them off, therefore, his near vision is improved.

At the risk of throwing doubt on a cherished family tradition I might say that your great-uncle Ezra who could read without glasses at seventy — or was it eighty? — was probably not a remarkable man, but just a nearsighted one. This is also the basis for most of the other miraculous stories that you hear. "My Aunt Hepzibah threw her glasses away at the age of sixty-five and could read without them — just like a young girl." You rarely hear anything about the good aunt's distant vision in these stories. But the chances are that she could not recognize a soul ten feet away from her.

Thus, if you are nearsighted and forty-five, instead of having a normal near point of about 12 inches you may have one of 8 or 6 or even 4 inches, depending on how nearsighted you are. And you may be five or ten or more years late in catching up with your old sight. Or, praise be, you may never reach it.

The hyperopic or farsighted individual has exactly the reverse situation to contend with. He may need a special reading glass at the age of thirty-five or even thirty. Again this depends on how farsighted he is. If his hyperopia is of high degree, he has to use some of his accommodative power for distance vision, as explained before, and as a result he has that much less for near. Hence he may require help for reading, writing, and studying at a much earlier age.

Long chronic and acute diseases may also help to weaken our powers of accommodation at an early age. This may be

transient if the proper care is taken, or it may be permanent and may attack the myope as well as the hyperope.

Along with our loss of ability to see near comes also an increase in the *time* necessary to adjust our eyes from distant to near and vice versa. This explains why a newspaper will begin to "clear up" after a while. Here is another cause of eyestrain, unless the proper correction for the eyes is worn.

In the early stages of old sight a stronger light may be sufficient. Holding things farther away may also help, because this decreases the amount of accommodating we have to do. But these are temporary measures, and to keep our ability to read in comfort most of us finally have to get glasses.

It has been determined that the best reading distance is somewhere between 13 and 15 inches from the eye. Reading glasses are therefore usually prescribed to give good vision at this distance, and reading matter should not be held closer.

If the patient has never worn glasses before, he should remember that glass lenses, unlike the living lenses inside our eyes, cannot change their focus automatically. Hence reading glasses are good at the near range only, but for distance the vision is blurred. I mention this because some patients are surprised when told that they will have to take their glasses off in the movies. If they have been wearing distance glasses they will, of course, have to change back to them.

Not only that, but, being inelastic, glasses are best adapted for one optimum point. Within or beyond this point the eyes themselves have to do the adjusting, and the older they are the less adjusting they can do. Thus the glasses may be excellent at 14 inches from the eyes but not so good for looking at the dummy's hand across the bridge table. Or they may not be right for the artist painting at arm's length or for the musician with the music 30 inches away on the music stand. The professional may need more than two pairs of glasses for ideal vision on all occasions.

All this means compromises and adjustments that some persons find it difficult to make. But until we solve a few more riddles we shall just have to go on this way, each one of us

sadly discovering for himself that as we get older the business of seeing becomes more and more complicated.

For those already wearing glasses another problem is posed. "Shall I get two pairs of glasses or bifocals?" The latter are the two-in-one glasses which have an upper segment for distant vision and a lower segment for near. When Benjamin Franklin around 1760 invented the bifocal lens he made a definite contribution to the efficiency of glasses and also to their unpopularity. Many wearing them for the first time wish that Franklin had stuck to lightning, at least until they have become accustomed to their new acquisitions.

One of the lesser objections to bifocals is that they give away your age, and many reject them for this reason. This fault has been minimized to some extent by the newer one-piece lenses in which the dividing line between the upper and lower segments is almost — not quite — invisible. Another and more important objection is that it is sometimes difficult for the eyes to accustom themselves to moving from one segment to another of varying strength. The size and shape of objects appear somewhat changed and the "jump" or step in between is confusing. The sidewalk seems to come up to meet you, and walking downstairs is a hazard at first.

The patient must educate himself to look and walk all over again and must not try to peer through the lower or near segment at objects that are too far away. All this sounds more difficult than it really is, and most people accustom themselves to their new kind of vision quite readily. Once the orientation is complete, bifocals are an undoubted convenience, because they do away with the necessity for constantly changing glasses when looking from near to distant objects and back again. We all come to them eventually except for a few stubborn souls who never give in.

Another question sometimes asked is why the lower segments in bifocal glasses are not set in the exact center of the lens but in toward the nose. The reason is this: When we look off into the distance our eyes are straight, but as we look at things nearer to us our eyes have to converge more and more. Hence for clearest vision the centers of the lenses

through which we look have to be nearer together in the lower near segments than in the upper (distance) segments. Bifocals come in various shapes and sizes, and the physician will inquire into your occupation and avocation and prescribe the type best suited to your needs.

For some, getting reading glasses constitutes the first eye examination they have ever had. They are fortunate; first, in not needing glasses until such a relatively late age, and, secondly, because at this time the eye begins to fall heir to the diseases of middle age, and if they are present a good medical eye examination may sometimes prevent them or at least minimize their progress by proper care.

The organs which we use to survey the complicated works of creation are obviously not too simple themselves. They need constant care and watching. They are living things which feel the wear and tear of life and age and work just as the rest of the body does.

The primitive races may have had better eyes than we have, or they may have had all our ocular defects. But they were not troubled so much by the defects they had, because they used their eyes less intensively. Also, most of them did not live long enough in those good old days to worry much about old sight. The hundred-year-old savage chief or medicine man was the rare exception, because the average life span a couple of hundred years ago was half that of ours or less. Presbyopia was the least of their worries.

We who live with our eyes longer than man has ever lived before *have* to make adjustments to them. I do not say that this is always easy. But it is inevitable. And it is better for us and our eyes to resign ourselves gracefully and see well than to fight a hopeless battle and not see well into the bargain. There are people, doctors among them, who resent growing old and advertising their chronological progress to the world. They fool no one but themselves. The individual who is successful in wearing a naked face with comfort all his life is fortunate indeed – and very rare.

V

Eyeglasses

We like to think that we are the rulers of the animal kingdom, the final perfected product of the evolutionary process. Rulers we may be; final perhaps. But perfected – no; unless our standards are very, very low.

No better proof of our lack of physical perfection is necessary than figures published by the U. S. Army and Selective Service officials. These show that approximately one-third of all men examined were barred from active duty because of physical defects. Twenty per cent of those rejected failed to qualify because of deficient eyesight. Most of these men with too little vision to become soldiers had never worn glasses, did not know how poor their vision was, and could not understand why they were rejected; especially since many of them had licenses to drive motor cars.

This is no place to go into the various military and social aspects of the subject, but I do think that it is important here to look unblinkingly at several pertinent if unpleasant facts.

First, it should be remembered that the men examined represented a cross-section of young adult American manhood. Secondly, the visual requirements for a 1A classification were far less than the "normal" 20/20. (They were only 20/100 in each eye, correctible with glasses to 20/40. Later this was reduced to 20/200 correctible to 20/40.) * Thirdly, it is a much simpler proposition to restore, say, some of the thirty-two neglected teeth than two neglected eyes. And, finally, there is the fourth inescapable fact that eyeglasses

* This is not only true of our own fighting men. The incidence of poor vision among German prisoners of war whom I had occasion to examine was at least as great, if not greater.

stand close to the top, if indeed they do not head the list, of eye conservation measures.

Perhaps these various facts seem unrelated to you. If so, let us stir them together, allow them to settle for a while, and then see what we get. No matter how we analyze it, the result shows that a substantial percentage of what should be the healthiest and most vigorous segment of our population has bad vision. Many do not know it. Others may know, but do little about it; they certainly do not bestir themselves to the extent of getting needed glasses. For still others it is too late to do much of anything.

When we take the larger viewpoint and examine a cross-section of all age-groups the picture is even less bright, visually speaking. In fact, this chapter directly concerns two out of every three readers — those who wear or should wear glasses.

I think that the most curious single aspect of this whole confusing eyeglass problem is that so many need glasses without knowing or caring. Some of the possible reasons for this are given below. However, lack of educative effort and advertising enterprise by those who make and sell eyeglasses is not one of them.

Now I do not know how you feel about it, but I happen to be one of a staid, old-fashioned minority who still believe that glasses were made to see with, not to be seen with. And I am tired of having newspapers, magazines, and billboards promise to improve my health, disposition, personality, appetite, and business prospects in big letters and my vision in little ones. I am weary of the persuasive radio voice that promises to beautify my undoubtedly plain face and enhance my social desirability by the simple expedient of selling me — very cheaply — a most expensive pair of glasses. I resent having my eyes and intelligence assaulted by ubiquitous store-window lithographs in which a most unbeautiful slattern is miraculously transformed into a paragon of health and beauty by a shining pair of noseglasses. It's bad enough that I have to wear glasses. Why add insult?

My objection to the making of aristocratic ornaments and social assets out of the plebeian spectacle is twofold. First, I deplore the commercialization of what I consider to be a medical function. Secondly, as an average adult I can but revolt at this implied insult to my fairly average intelligence. On the other hand it must be admitted in all fairness that there is a solid basis for this excursion of commerce into the stratosphere of imagination — a cold, hard set of statistics that runs something like this:

1. One out of five school children needs glasses.
2. Two out of five college students brighten the campus with spectacles, or should.
3. After the age of forty-five most of us, as we have seen, need reading glasses if no other kind.
4. All in all, approximately two out of three adults need glasses either permanently or intermittently.
5. Only one in three actually wears glasses.

I cannot vouch for the accuracy of the above figures. The old dictum about lies, damned lies, and statistics may be no less applicable here than anywhere else. But these estimates are more or less accepted by most authorities.

With two out of three individuals needing glasses, why do half that many deny themselves this blessing, despite all commercial blandishments and doctors' injunctions? Is it vanity? Partly. For it must be admitted that, except possibly for the studious look imparted, the esthetic appeal inherent in a pair of glasses — the most beauteous pair of glasses — exceeds only slightly the emotional content of a glass eye. I do not know a single woman who looks or thinks she looks better with glasses. Do you? I know not a single one who would not discard them if she could. Many do who should not. Why? Ignorance, carelessness, vanity — yes. But these are not the only reasons. For a fuller explanation we have to go back, 'way back.

We do not know who the inventor of spectacles was. But he must have been either an exceedingly modest man or a thoroughly frightened one. (There was plenty of justification for his fright, as you will see.) In fact, the very origin of optical media is shrouded in ancient obscurity. Vague, apoc-

ryphal reports of the Chaldeans using some sort of magnifying devices 4,000 years before Christ have filtered through. They probably used such materials as quartz or rock crystal, held in front of the eyes by hand.

Around 200 B.C. we hear of Archimedes setting fire to an attacking Roman fleet by focusing the sun's rays on their sails with powerful lenses or mirrors. It is hard to believe that they had such highly perfected optical instruments in those days. But it *is* a neat story. The old violinist, Nero, is said to have used a precious stone mounted in a ring as an aid to vision — the first monocle of history.

Somewhere in the middle of the Middle Ages human ingenuity hit upon the idea of sticking lenses into frames and hanging them in front of the eyes. It seems that, among others, the Chinese, the English Roger Bacon, an Italian named d'Armato, and a Dominican friar named Spina all invented eyeglasses. And they all invented them first, if you would believe the literature. Since the few facts we have are remarkable chiefly for their untrustworthiness, you may pick your own candidate for immortality.

The Chinese claim is backed by the restless Marco Polo, who is reported to have seen spectacles in China around the end of the thirteenth century. The report is vague, because his interest in them seems to have been overshadowed by his delighted appreciation of that far greater boon to humanity, gunpowder. I cannot vouch for Roger Bacon's claim to priority, though it seems well established that he did use some sort of magnifying lenses. And he is known to have sent a convex glass to Pope Clement IV as an aid to reading.

D'Armato offers the only documentary evidence — if you want to call it that. His tombstone bears the well-known inscription: "Here lies Salvino d'Armato of the Armati of Florence. Inventor of spectacles. God pardon him his sins. A.D. 1317." Of Spina little is known except that he died in 1313.

When spectacles burst forth in all their vitreous splendor on a startled world, the pious raised their hands in holy horror. They were outraged at this blasphemous attempt to improve on the handiwork of the Almighty. Those whom the

Lord made blind were not intended to see. And they inveighed against these instruments of the devil, which should never, never desecrate their holy noses, with all the heartiness that only a righteous zeal can evoke. No wonder the inventor, whoever he was, hid his light under a bushel. Thus at their very inception eyeglasses came into the world accursed.

First made in Venice, medieval center of the glass industry, and then in Germany, spectacles were adopted but slowly at first, and mostly by the older male population. Lack of feminine enthusiasm is adequately explained by existing portraits immortalizing the crude, unwieldy monstrosities of the fourteenth century.

As time went on the obvious value of eyeglasses — even those early atrocities — made sacred interdictions not wholly successful. The educated and wealthy began to adopt them slowly. Thus in 1386 we already have Chaucer alluding to the "spectakel . . . through which he may his veray frendes see." And in some unregenerate circles they even became a mark of intelligence, to be worn whether or nay. In seventeenth-century Spain glasses "were taken in high society as signs of elegance, distinction, superiority, and gravity." And you remember Tom Sawyer's aunt, who later wore spectacles "built 'for style,' not service — she could have seen through a pair of stovelids just as well."

It is a far cry from the crude spectacles of those early days to the modern pair of glasses, which, comparatively, is a thing of beauty if not a joy forever. Science has not only enabled us to see better with them, but has given them to us in sizes, colors, materials, shapes, and styles to please the most exacting, with a few left over for the less finicky. Word even comes of a new plastic material, lighter and less fragile than glass, that may in time replace glass spectacles.

Unfortunately, these improvements have brought with them a whole new crop of superstitions. For the years have added a whole mythology, or rather demonology, to our ancient prejudices. Accordingly, so the story goes, malignant spirits lurk in every pair of innocent-appearing cheaters.

These evil genii so bewitch you that, once having donned eyeglasses, you are forever after a slave to them. Or, they weaken your eyes so that never again are they as good as before you took the fatal step. It does no good to point out the obvious falsity of these beliefs. They are rooted too deep in the prestige of age.

Now what is the Truth? The truth – let's not be too pontifical – is that eyeglasses have been developed by human ingenuity to help the eyes to see. They are our only means of correcting many structural, muscular, and senile eye defects. In many cases they not only help us to see better, but they also relieve us of such symptoms as headache, eyestrain, burning, itching, and redness of the eyes – symptoms that may be due to eyes and eye muscles in need of help.

We wear glasses for two primary reasons. In order of importance they are (1) to be comfortable and (2) to see well. You will note that comfort comes first; it was not always so. At their inception in the thirteenth century glasses were worn simply to improve vision. It was not until the 1870's – a matter of six hundred years – that the connection between general bodily symptoms and eyestrain was pointed out by Dr. S. Weir Mitchell of Philadelphia. He was a neurologist who noticed that many of his patients complaining of headache, nervousness, dizziness, and other general symptoms, who could not be relieved in other ways, were often benefited by properly fitted glasses.

Dr. Mitchell more than anyone deserves the credit of showing us that the prescribing of glasses, hitherto almost entirely in the hands of the non-medical technician, is a proper function of the physician. Since his day eyeglasses have become an important therapeutic instrument in the hands of the doctor. And from the medical point of view glasses are at least as important for the treatment of various general bodily disorders traceable to poor eyes as they are for the improvement of vision. That is why I place comfort ahead of vision. Of course, the two are closely bound together; but the comfort and freedom from general symptoms that eyeglasses give are of paramount importance.

As a matter of fact, there is such a thing as making a patient uncomfortable by enabling him to see too well. Many, especially nearsighted people, whose retinæ are particularly sensitive, are happier when they do not see things in too fine detail. This is also true in some cases where the refractive correction is high. Occasionally these individuals are much more at ease when their prescription is weakened and their vision reduced to less than maximum. The rule, therefore, is to give the patient the best vision that is compatible with comfort and with health of eye and body.

Glasses enable the eye to work more efficiently by doing to light rays what the faulty eye cannot do for itself. But it is well to remember that eyes when given "normal" vision with glasses are still not as good intrinsically as the eyes that need no glasses, despite the equality of vision. Worked beyond their capacity, such eyes often rebel. Hence they must be treated reasonably and rested occasionally.

Glasses cannot make the imperfect eye perfect, because they cannot change the anatomic structure of the eye. Hence even wearing the wrong glasses does not always injure the eye permanently; else there would be a good many more eye troubles than there are. Glasses neither "strengthen" nor "weaken" eyes in the commonly accepted sense. True, some who have worn glasses in childhood have later discarded them. It is not the glasses, however, that are responsible for such beneficent miracles. They merely help during the formative years until the eyes become old enough and strong enough to fight their own battles.

Likewise when you hear people say: "I don't want to start wearing glasses, because I'll have to wear them all the time," you are in the presence of a myth. We simply forget how poorly we once saw, and, having become accustomed to better things, we find the change so marked when the glasses are removed that we think the eyes have become "spoiled." Having become used to seeing better with glasses, the eyes rebel at poorer vision when the glasses are taken off. It is not because they have changed. The remarkable fables extant about the malevolent effect of glasses are – fables.

On the opposite side of the picture are the non-glass-wearers who honestly believe that they see well and who are much surprised when an examination discloses poor vision. I have already referred to the many adults, especially the nearsighted, who actually have not the slightest conception of what it is to see the daily world as you and I see it. Such people, wearing glasses for the first time, feel as if they have stepped into another world, the transformation is so great.

The reason so many poor-sighted individuals get along so well is that vision is not entirely a matter of ability to discern fine details. It is a complex process composed of many factors including contrast, color, memory, experience, intelligence, training, etc., etc. Thus, given equal visual power, the educated person may actually read lower on the eye-testing chart than the person of lesser education or slower mental faculties. The former is aided in the recognition of the letters not only by his good vision but also by his longer contact with letters and his more alert intelligence. For similar reasons children of the same visual ability as adults usually see less in a vision test.

People with poor vision may have little trouble in the movies, because there is little necessity here for the discrimination of fine details; the figures are large, and the contrast between the bright background and the dark figures makes them easy to see. This is also why black print on a nice white background is easier to read than on a gray background. Such people, if there are no symptoms of eyestrain, may go along for years without knowing that it is possible to see better until they discover it accidentally during a life insurance examination or a civil service test.

This whole business of eyeglasses and eyeglass wearing has been unnecessarily bemuddled, mostly by virtue of high-pressure commercial publicity. I want to state my view as briefly and as reasonably as I can:

Not all of us can or even have to see 20/20. I have previously shown that some of us are better off with less. Nor am I overmuch concerned (and this will be considered heresy in some quarters) with whether a man does or does not wear

glasses – yes, even if he sees better with them – as long as he is entirely *comfortable* and content with poorer vision. The vast majority of us want to see as well as the Almighty will let us, and for most of us optimum vision means optimum visual comfort. This much is certain and beyond cavil. On the other hand many who could use glasses get along without them and are content. They have the kind of nervous makeup that can withstand the sort of eye treatment that would make life almost unbearable for others, given the same pair of eyes. Such people are in about the same class as the many who wear improperly prescribed glasses for years with no discomfort. To predict dire visual calamity for such people is, I am afraid, nonsense.

In the armed services certain *minimum* visual standards must be met, with and without glasses, which vary with the duties of the particular individuals. This is obvious and necessary. But no attempt is made to give each man and woman visual perfection, even if it were possible, because it is not necessary. And certainly the rigors of military life require as good vision as civilian pursuits. The test in all cases, then, is not whether an eye meets some arbitrary visual standard, but whether it is otherwise healthy and always able to do its job comfortably.

When the inevitable cannot be staved off any longer and glasses must be worn, there are certain questions which patients invariably ask. "Do I have to wear the glasses all the time?" is a favorite. Such a question is hard to answer categorically. Each case is a special problem, to be discussed with the physician and decided individually. In general, let me say that an eye that needs glasses is never better off without them. You may have to wear them every waking moment of the day and night. On the other hand it may only be necessary to wear them when the eyes are at work: reading, sewing, knitting, in school, office, movies, theater, etc. You may be able to dispense with them on the street, at a party, or at a dance, where the eyes are not used intensively.

It is not giving away any trade secrets to state that an eye physician, even when he feels that glasses had best be worn

all the time, must sometimes compromise and settle for less. He knows that unless this is done some patients will simply not wear their glasses at all. It is a harsh thing to say, but the doctor is often driven to desperation by nearsighted ladies who come year after year religiously to have their glasses examined, spend energy, time, and money for glasses, and then wear them in their handbags.

Or some, when asked if they wear their glasses, will say: "Yes, when my eyes feel tired." Just why should one wait until the eyes "feel tired" to wear the glasses obtained to prevent that very thing? Perhaps such sales slogans as "make the long nose shorter" (or vice versa), "conceal the bump on your nose," and "add a smart, nonchalant touch to your costume" *are* justified after all. It's hard to think of eyeglasses necessary to health and comfort as articles touted for personal adornment, but there are cases in which even this means of making a person wear necessary glasses seems justified.

Another question frequently asked is the type of frame to buy. In most cases it really does not matter very much. For those wearing the stronger corrections, requiring heavier lenses, the full frame is better than the rimless type, because of its greater firmness and solidity. This is especially true if the lens contains a correction for astigmatism. You will remember that such lenses have to be set in front of the eye at an exact angle for clearest vision. The least twist will make things look blurry, especially if the astigmatism is of high degree; hence the more solid frame is preferable here. In such cases another word of caution is necessary. Don't get frames that are perfectly round. Round lenses will sometimes turn in their frames because of constant jolting and handling or the twisting motion of wiping—when you do wipe them. This will throw them out of alignment, and they will require frequent adjustment.

For the same reason it is a good thing that not many oxfords are worn these days. These are the lenses that are fastened together by a long spring and, frequently, attached to a long black ribbon around the neck. Not having earpieces, they may not always be set in the same place on the nose; or the

spring may become loose and sag. These, too, are to be especially avoided in cases of astigmatism.

The position of the lens in front of the eye is important for still another reason. The convex lenses, i.e. those worn for farsightedness and old sight, increase in power the farther they are from the eye. Hence a glass that has to be worn far down toward the end of the nose is probably too weak. In the case of the concave lenses, those worn for nearsightedness, the nearer the lens is to the eye the stronger it is. This is why you sometimes see nearsighted folks pushing their glasses closer to the face when they want to see well. This also means that the glasses are too weak and need changing. Hence the importance of getting glasses properly fitted to begin with.

As to the material and style of frame, your taste, pocketbook, and optician will decide that. Lenses work as well in a tortoiseshell frame as in one made of solid gold, if fitted properly. Nor does it make much difference whether the earpieces are attached to the center or the top of the side of the lens. It is wise to get your glasses at a reliable place. Not only does this assure a proper fit, but glasses are a blind article, and the market is flooded with low-grade lenses that are hard to distinguish from the better quality. The reliability of your optician is your best protection.

Many patients are concerned about "thick" glasses. Lens grinding has made such progress that glasses can be made much thinner and lighter today than they used to be. However, in extreme cases thick glasses are still necessary if decent vision is to be preserved. And while on the subject let me say that it is not only the nearsighted who have to wear thick lenses. There are farsighted people who also need them. Misconceptions about this are partly explained by the fact that there are more *very* nearsighted than *very* farsighted people; though in the moderate degrees the farsighted outnumber the nearsighted. If the eye appears small through the glass, the person is nearsighted; if large, he is farsighted.

Much thought has gone into improving the appearance and disappearance of glasses – thick or thin. There are the

easily hidden folding-glasses that can be whisked out of sight after use. The beribboned oxford and the aristocratic lorgnette can also be discreetly tucked away. The monocle, too, is quickly disposable. And it is often more than a curious affectation. It is not quite so useless as it might appear. Our Continental cousins have a talent for making a virtue of necessity. On close investigation you will usually find that the monocle is a well-ground lens that helps its wearer see with that one eye. Of course, the monocle does require facial contortions that make one wonder whether the result is worth the effort. But it is a convenient gadget when all is said.

The latest wrinkle in eyeglasses is the contact lens. This is the little shell of glass that is placed directly on the eyeball behind the lids. As is the case with many new inventions, the germs of the idea are quite old. As early as 1827 Herschel, the English physicist, suggested these "invisible" lenses. But at that time they had not perfected the art of grinding and fitting optical glass to the fine point at which we have arrived. Nor had glasses become so common and unpopular.

And yet, with all our improved methods, the contact lens cannot displace the framed spectacle. Original enthusiastic expectations have not been borne out completely. It is true that some patients can wear contact lenses comfortably. And they are practically invisible, which is of course an important advantage to the general public. But others can wear them for only a few hours at a time. In such conditions as pinkeye, hay fever, distortion of the lids, etc., they cannot and should not be used. They are still expensive and fragile, and they often require long and troublesome adjustment. With all the publicity that they have received, it is estimated that there are altogether probably no more than 5,000 to 6,000 people in this country who use them today.

Recently they have been made by taking an exact cast of the front of the eye and then making a contact shell of glass from this mold. This is an improvement over the old trial-and-error method of fitting stock lenses until the most nearly suitable one is found. Within the past few years, also, some have been made of plastic material, which answers the objec-

tion of fragility. On the other hand, these scratch more easily.

Contact lenses are of definite value in some disease conditions, such as scars and irregularities of the cornea, and in paralysis of the lids, which prevents complete closure of the eye and thus exposes the cornea to drying and infection. Also, in cases where a cataract has been removed from one eye they have been used successfully to equalize the vision of the two eyes. They have also been suggested for use by athletes in the rougher sports, where ordinary glasses are a hazard. They are valuable in the very high degrees of nearsightedness and farsightedness, especially in the case of public performers who wish to conceal their visual infirmities from an adoring public. They are indicated in cases where eyeglasses are useless or wholly impractical.

Contact lenses have been so highly publicized that they are now found in queer company and put to extremely original uses. Recently a movie had the villain disguise himself by wearing a pair of colored contact lenses to change the color of his eyes. As time goes on contact lenses may be perfected sufficiently to replace more and more the thick, unsightly lenses of the very nearsighted and farsighted. But at present they are not yet quite the complete answer to the myopic maiden's prayer.

And now for a few don'ts.

Don't put off that eye examination because you feel that you will inevitably end up with a prescription for glasses. You may not need glasses at all; your symptoms may be due to something else entirely. About a third of all patients who walk into the eye physician's office resigned to glasses are happily disappointed to find that they do not need them after all.

Don't buy your glasses by long distance. I have already shown how important it is that they be adjusted to the face by a competent workman for maximum efficiency. This is only one of the objections to buying mail-order glasses. (Some still do, you know.) It is at least as important to have glasses properly fitted as shoes; and they require adjustment and repair every once in a while. Don't send for them; go yourself.

Don't fit yourself with a pair of glasses from a store counter. There are still a few individuals who have such confidence in their own, diagnostic abilities that, exercising their rights and privileges as free citizens, they proceed to buy their own glasses without a previous examination. This form of self-therapy has been outlawed in most states, but it can still be done in a few localities. The method here is one of trial and error purely — about 99 per cent pure error. The minor inconveniences of fitting yourself with a cheap pair of store glasses are many. Such lenses scratch easily, are unevenly surfaced, and give color reflexes — not always rosy. Ill-fitting frames cut the nose, chafe the ears, and slide all over the face. But of greater importance is the fact that such glasses are made presumably with both lenses of equal strength. Now of all rare things that the Lord has manufactured, a pair of identical eyes is one of the rarest. And the purchaser must therefore resort to the Procrustean method of fitting his eyes to his glasses, a system not recommended for comfort. Being exceedingly efficient instruments, in spite of their delicacy, the eyes can adapt themselves to abuse for a long time. Being inarticulate, they cannot shout for help, but must wait until the load becomes unbearable before relief is obtained. And other possible trouble may also be overlooked. It's a mean trick to play on the eyes.

Don't be one of the many glass-wearers who do not know whether they are nearsighted or farsighted. If you are interested — and you should be — it is easy to find out. Hold your glasses about ten inches in front of your eyes and close one eye. With the other look through one lens at a time at some object not too far away. Now move the lens slowly up and down, and back and forth. If the object looked at moves with the lens it is a concave or nearsighted correction; if against, it is a convex or farsighted glass.

To determine an astigmatic correction look through the glass at some straight line, such as the edge of a bookcase or window-frame. Now turn your glasses slowly so that the lenses are one above the other instead of side by side as normally worn. If during this maneuver the line looked at re-

mains straight, there is no astigmatic correction. If it appears to break, then you have such a correction incorporated into your glasses. Some will find lenses through which the object looked at moves *with* in one direction and *against* in the other. These are for eyes with so-called mixed astigmatism, which are nearsighted in one meridian and farsighted in the other.

Don't leave your eyeglasses lying around naked and don't set them down so that they rest on the lenses. This will get them all scratched up very soon and will cloud the vision. Tucking them into a book for safekeeping is also very poor reasoning; nowhere are they as likely to get squashed. And wipe them, occasionally at least. Why handicap yourself with an artificial fog?

And, finally, don't repine too much about having to wear glasses. Many dislike it, few love it. But, sometime when you feel particularly rebellious, try answering this question: Would you rather that eyeglasses had never been invented?

VI

Our Colored World

Britain was losing ship after ship with monotonous, unpleasant regularity. Despite the all-over coat of neutral gray that had replaced the old-fashioned white superstructure and black hull in the naval color scheme, German submarines refused to be fooled. The British attempt to blend ships into the anonymity of the horizon was a failure in the face of modern scientific instruments of sight and sound detection. What to do?

In desperation a daring idea was evolved. If the enemy could not be evaded, maybe he could be confused. When the Lords of the Admiralty first got a glimpse of the camouflaged or "dazzle-painted" ship they thought – when sufficiently recovered to do any thinking – that the general idea was to stun the German U-boat commanders into a chromatic stupor with this colored bombshell. Their second reaction was one of outraged protest. It was contrary to all theories, it was contrary to reason, it was contrary to this and contrary to that. But it was not any of these things, because it worked. It worked beautifully.

Casualties of the merchant fleet dropped at once, because the Germans found themselves shooting at oncoming vessels when they were really going. They fired torpedoes at ships apparently sailing to starboard, actually going to port. The crazy-quilt of violently contrasting colors, a futuristic madman's dream, was so cleverly applied that, though the vessel could not but be spotted, to plot its course was a hopeless task. And you cannot hit a target unless you know where it is going to be at a certain instant. Colors – a hundred rainbows gone berserk – were saving thousands of lives and millions of tons of life-giving foodstuffs.

But joy soon changed to gloom again. Once more British bottoms began to keep rendezvous at the locker of the famous Davy Jones. Immediately the Allied espionage system got into action and brought back the answer. The Germans, also knowing a thing or two about colors, were using color filters in their periscopes. And torpedoes could again be accurately aimed. It was as simple as that.

A period of feverish research followed. Out of this came the discovery that white, black, and some dark blue, used with due respect for the laws of perspective, were just as effective as the previous more startling combinations in masking the course of vessels. And they were comparatively filter-proof. Before the end of the First World War the French, American, and Belgian navies had also been won over to the idea. No one knows how many lives and how much property were saved by this scientific use of colors.

That was the First World War. The Second has picked up where the First left off. With our increased knowledge, ships of the sea no longer frighten little children, but they are now harder to spot. Ships of the air are coated with flat black or special buff paints as protection against the deadly searchlight at night. For daylight raids, light blue on the under surface to blend with the sky, and darker colors on top to blend with the ground, are being tried. Conversely, men in every army are working desperately, devising ingenious color schemes to make aircraft hangars and ammunition plants invisible from the air. And the U.S. Army has designed a "sniper suit" said to be invisible at normal firing range.

The use of colors in man's most popular pastime, war, dates back as far as we can go. For instance, we have the Biblical injunction: "The children of Israel shall pitch every man by his own standard" (Num. ii, 2). And the supposedly unwarlike Chinese in their Book of War written before 500 B.C. describe "the flag . . . to assist the sight" on the field of battle. In olden days colored flags and standards were used to differentiate the knights and barons from the common soldier rabble and to facilitate assembly for attack. The "colors" served as a rallying point, and as long as they were up, sol-

diers knew where they belonged. With the advent and perfection of long-range firearms these brilliantly conspicuous paraphernalia of Mars became so unsalutary (the mortality of standard-bearers as late as the Crimean War was terrific) that they rapidly lost their popularity.

So the pendulum swung the other way. Now color has become a defensive instead of an offensive weapon. Armies are dressed in khaki, olive-drab, greenish-gray, etc., to blend them with their surroundings. And though an army marches on its belly today, as it did presumably in Napoleon's time, its progress is now much more inconspicuous.

In other words, at this late date we have learned to do what nature has always done for animals much lower in the evolutionary scale. The hare and the ptarmigan change to inconspicuous white fur and feathers with the coming of the first snows. In desert regions birds blend into their surroundings because of their sandy coloration. The zebra's seemingly conspicuous black and white stripes merge into the chiaroscuro of its environment, especially by moonlight. The bright patch of color which is the butterfly resting on a green leaf disappears in a field of flowers. The cuttlefish in the briny deep creates its own protective environment by releasing the contents of its ink-sac when in danger. In the case of animals scientists call this simply protective coloration. For our own human benefit we have managed to invent the rather oblique term camouflage.

Whether the lower animals do these things knowingly, even whether they have any color perception at all, is still far from settled. Apparently most birds and insects are color blind. It seems a pity that the brilliant-colored plumage of many male birds should be wasted on the unappreciative color-blind females, but that seems to be the case. It also seems established that the color displays by such animals as the fiddler crabs and the spider during the courtship period are all for naught. The sex-attracting signal light of the firefly is more understandable. And higher up in the animal scale there are the owl, the dog, and the bull, to name but a few, who are totally color blind.

A waving red flag is not an inimical color but a challenging movement to the bull. Try it sometime with a green or yellow flag — but get behind a good stout fence first. To most of the lower species the odor world is much more important than the color world, and most animals live by smell, not sight. It is said, for instance, that elephants see thirty yards away and can smell at eight hundred yards.

As we go up the animal scale to its highest development, man, the situation is reversed. For from the time that green-eyed Eve tempted brown-skinned Adam with a red, red apple color has played an important part in our lives — your life and mine. Even here there is reason to believe that color perception is a relatively late acquisition.

Our ancestors, long after they climbed down from the tree-tops and got their land-legs, were apparently color blind. The evidence is not conclusive, but here are the facts (add them up and see what you get): (1) In all of Homer's writing of 3,000 years ago — a mere instant in universal time — with its beautiful imagery and vivid description, there is little mention of colors. The Iliad, for example, mentions only an occasional red and yellow just once. (2) The Bible is relatively poor in color allusions. (3) Only a few of the lower animals, i.e. those nearer the primitive state of evolution, have any color perception. (4) Babies do not have any color perception until after they are three months old or later — long after they can see. And they cannot distinguish one color from another until they are about fifteen months old or later. (5) Among present-day primitive races, notably natives of the Carolines in Polynesia, the same word is used to denote green, blue, and black, so little distinction is there.

As far as we can learn, human beings first learned to recognize black and white, then red and yellow, and finally green and blue. Later came even greater specialization. It is believed by many that color blindness is merely a throwback to simian forebears who also did not have color vision. But ours has become, though belatedly, an entirely colored existence; witness the sky overhead, the fields below, the homes we live in, the clothes we wear. We cheer for our school colors

and fight for our country's. Variously hued lights direct our daily movements horizontally on roads and vertically in buildings. Colored scenes titillate our eyes and colored foods our palates. Our moods, philosophies, sensations, all human qualities are defined in terms of fractions of the spectrum.

Our literature is full of chromatic allusions. The only surprising thing is that so few agree as to the meaning of particular colors. Thus Charles Kingsley's

> "Oh, green is the color of faith and truth,
> And rose the color of love and youth"

is excellent poetry, but not a universally accepted color concept. To most of us green means youth and inexperience. Shakespeare, for instance, lets Cleopatra describe herself as "green in judgment." But even he, inconsistently, speaks of "green and yellow melancholy." Then there is blue, which is the popular choice for truth, but it may also typify justice and despondency. Red has always meant passion, but it also stands for such diverse qualities as courage and sin. (Incidentally, in a number of investigations red has proved to be the most popular color among both men and women.) Lanier says "blue for hope and red for fear," and the old childhood jingle boosts blue with

> "Oh, yellow's forsaken and green is foresworn;
> But blue is the swellest color of all."

White may imply such varied things as victory, joy, innocence, and cowardice. And purple may denote wealth, power, royalty, penitence, and mourning. Black seems to be the most standard of all. Universally it symbolizes evil and despair.

Perhaps special mention should be made of the eyes themselves with which we see all colors. Inevitably, attempts have been made to correlate eye color with certain types of character. Thus gray is for perseverance, black for ambition, and hazel for activity. The brown eye is linked with nearsightedness, high intelligence, and the cloistered study; while the

blue eye has been attributed to the farsighted, more athletically inclined, less studious individuals. All I can say is that the exceptions disprove these rules.

I do not know what makes the soulful blue eye soulful, but it is blue because it has not enough pigment to make it brown. This is why blue eyes are so frequently associated with the blond, less pigmented type of individual. And that is also why blue eyes are found in all newborn babes. The pigment develops later. Thus a physiological imperfection becomes a desirable human attribute – like that much envied anatomic defect in the cheek of the winsome maid, the dimple.

Eye color or the lack of it is not an accidental phenomenon, but is passed along by parents to children by regular laws of heredity, the same as color blindness and hemophilia. It can be stated with fair certainty that two truly blue-eyed parents cannot have a brown-eyed child. The reverse is possible and common. And color blindness is as incurable as hemophilia.

But there are some five or six million people in this country alone to whom many of these metaphorical color allusions are empty figures of speech, meaningless phrases. These are the folk who have normal vision except that they lack the ability to recognize all colors. We do not know why; only that it seems to be something which is inherited along with the family name. Unlike the latter, however, it cannot be changed if you do not like it.

Color blindness (achromatopsia) has been known to us for centuries, but it remained for John Dalton, the famous English scientist and discoverer of the atomic theory, to arouse scientific interest in the subject. An acute observer, he published the results of studies of his own defective color vision in 1794. To this day Daltonism has been another name for color blindness. And this paper was the opening gun in a heated scientific battle of words and ideas that has never ceased raging. You will see why shortly.

Approximately one in every twenty males cannot pick out the finer shades of some colors; and two out of every hundred are unable to distinguish certain of the primary colors at all.

Is this 29 or 70? If the latter, you are red-green blind

Do you see the figure 6 easily? If not, your color vision is poor

But only one-fortieth as many females are color blind. This is because color blindness is sex-linked and is usually what scientists call a recessive characteristic. Or, to put it less drily, females have conspired with nature (as Bernard Shaw would say) to pass it on mostly to their male offspring, leaving themselves relatively immune and able to appreciate the full glory of our color-filled world.

Fortunately only a few of the total number are completely color blind. These see all colors in varying shades of gray. The fact that there are some 572 different gray shades does not make their life the less drab. The golden sunset, blue eyes, rainbow trout, and technicolor movies are all wasted on them. They live under constantly leaden skies in permanent twilight.

The majority of those having faulty color perception are red-green blind. These range all the way from the inability to distinguish any but the brighter shades of red and green (color confusion) to those seeing all shades of red and green as grays of different intensities (true red-green color blindness). To these a red Tweedledum and a green Tweedledee would really look alike.

As I said, we cannot explain color blindness, we can only deplore it. Perhaps if we knew why most of us *do* see colors we could tell why some of us do not. Let us start with the things we do know.

We have seen (Chapter II) how the retina is specialized into a small central cone-containing portion and a large peripheral rod-containing portion. The former has to do with daylight and fine-detailed vision, while the latter gives us movement vision and the ability to see in poor illumination. Now how does this concern us here?

It is important because color vision is confined to the central cones only. *No color can be seen with the peripheral rods.* So much we know definitely, and we are still on firm footing. It is when we come to the question of *why* we see colors that we begin to stumble around. Truly color, like beauty, is in the eyes of the beholder; but we know not where or how.

In an effort to explain the mechanism of color vision many

guesses have been made. We call them "theories" because it sounds better. Each theory is backed by as fanatic a set of partisans as ever burned a witch or waged a holy crusade. All these color theories start from the same premise: that there are two different structures in the eye that help us to see, the rods and cones described above. They all agree that the rods are connected with twilight (colorless) vision and the cones with daylight (color) vision. But from here they wend their separate ways alone.

The most plausible and commonly accepted is the Young-Helmholtz theory. Stripped to bare essentials, this says that there are three fundamental colors: red, green, violet. (To make a complicated subject no clearer, some prefer carmine red, yellowish green, and ultramarine blue as the fundamental colors.) Correspondingly there are three types of cones, each of which is stimulated only by its respective color. Thus, if a red light is thrown in your eye your red receptor cones are stimulated and you see red; and so on for the others. All other colors seen are due to stimulation of any two or three of these fundamental colors in proper proportion. Thus, red plus green gives yellow, green plus violet gives blue, orange is the red-green combination with red predominating, etc., etc. White is seen when all three types of cones are stimulated equally, and black when there is no light stimulus at all. There is much more of this, but that is the general idea.

Another important theory, appropriately labeled the Opponent Theory, was advanced by Ewald Hering, who saw colors a bit differently. He postulated the presence, somewhere in the visual pathways, of color-twin substances which he called green-red, blue-yellow, and black-white. These substances, according to him, were built up or broken down according to the kind of light rays acting on them. Thus some rays act on green-red only by breaking it down to red. Then another type of ray comes along and builds it up to green. The result is that we see red or green as the case may be. The same is true of the other combinations. White and black here, you will notice, are parts of an independent combination and are not due to a mixture or total absence of color. According

to Hering the other colors are seen by combination reactions, much as in the former theory. When the breaking-down and building-up processes are equal, no color is seen.

There are other theories: the McDougal, the Ladd-Franklin, the Edridge-Green, etc. They all add up to the fact that we still know very little about how we see colors, as you can see from this definition: Color is the sensation excited on the retina by the action of rays of light of definite wave-length.

We have some good ground for the belief that there is a special independent color mechanism, because it is possible to have good color vision without good central visual acuity. And, vice versa, as we have seen, people with otherwise normal vision can be color blind. It is postulated, therefore, that this is due to separate centers in the brain controlling these varying kinds of vision.

What little we do know about colors dates back to the seventeenth century, to a boy who saw an apple fall and wondered why it did not fall up instead of down. It is due to Isaac Newton's questioning mind that we owe much of our fundamental scientific knowledge – and not only about color. Newton was the Einstein of his day. Like his famous successor, he does not seem to have been much of a student in his youth. But around the age of fifteen, so the story goes, he had a fight with the school bully, whom he licked. That victory did something to him. From that day dates his interest in science and mathematics. The connection is difficult to see, but if this is the formula for Newtons, then by all means let us have more and better school fights. At the age of twenty-four Newton had already given to the world the binomial theorem, integral calculus, the law of gravitation, and his epoch-making discoveries in optics and light. With prosaic figures and dry mathematical formulæ he opened up vistas of the universe hitherto unknown and unexplored.

Working on a problem in optics with a glass prism, a wedge of glass wider at one end and tapering to a narrow edge at the other, Newton noticed that when a ray of sunlight hit the prism a remarkable thing happened. The white sunlight emerged transformed into a series of beautiful colors arranged

as follows: red, orange, yellow, green, blue, indigo, and violet. It did not take him long to realize that the prism had broken up white light into its component wave-lengths. The visible spectrum was born, and the true nature of the miracle that is the rainbow was explained: it is merely sunlight broken up by water drops in the air, acting as a huge prism. By proper methods it can be reassembled to white light again.

Colors are therefore literally bits of sunlight. And it is rather startling to contemplate that pure white light is the most complex of colors, while vivid reds and yellows and greens are the simpler.

In 1800 another interesting discovery was made. Herschel, working with an exceedingly delicate thermometer, discovered that it registered higher at the red end of the spectrum than at the violet end. Obviously the association of red with heat and of blue with cold is no idle figure of speech. And it was not long afterward that we learned about the invisible rays beyond the red end that supply us with heat. Their existence is easily proved by means of a glass screen, which is a poor heat conductor, placed around a fireplace. The flames are visible, but the heat is cut off.

Though these infra-red rays are invisible to the human eye, there is some evidence that many nocturnal birds and some insects are able to interpret infra-red radiations visually. It may be that we have some evolving still to do.

By 1850 it was established beyond doubt that there are invisible waves of radiant energy beyond both ends of the visible spectrum, and that, like the visible rays, these can be reflected, refracted, polarized, and even photographed. At the drop of a hat a camera enthusiast will tell you about the marvelous photographs taken through a filter that excludes all but the infra-red rays. In aviation photography especially, much use is now made of this filter, because it screens out the clouding effect of the scattered visible rays, thus giving much clearer topographical detail than ordinary pictures.

Now we know that this series of seven visible colors or wave-lengths is but one in a huge keyboard of more than sixty "octaves" of known though invisible radiant energy, varying

from the shortest X-rays, only millionths of an inch in length, to the miles-long waves generated by huge dynamos. And the end – at either extremity of this huge keyboard – is not yet in sight.

Color waves vary progressively in length from the longest red rays, which are 7651 Angstrom units long, down to the shortest violet rays, which are approximately half as long. (An Angstrom unit is one ten-millionth of a millimeter.) Hence our whole visible world is confined to less than one doubling of wave-length.

This makes an interesting comparison with the musical octave, in which the vibration frequencies are also doubled. But while we can normally see less than one light "octave," we can hear about ten and a half. Which would you rather have?

The relation of color to musical sound is an old one. Newton himself noted the similarity of arrangement of colors in the visible spectrum to the ratio of notes in the diatonic scale. And as far back as the seventeenth century a famous Jesuit mathematician, Castel, suggested a color-music organ. Since then and down to the present time color projection machines of various types have been brought forward. Many readers will still remember the old parlor kaleidoscope that was so popular in crinoline days. On the whole, however, this medium has not been successful, probably because most of us have learned to appreciate colors not for themselves alone – except in fireworks, perhaps – but only in relation to some familiar form or shape.

As if to compensate for the five per cent of us who are born color blind, scientists find that some of us have synesthesia, or colored hearing. They say that in about five per cent of the population certain sounds evoke certain color sensations, which vary with the individual. That is, a certain musical note will make one think of blue, another of green, and so on.

But to get back to the color spectrum: We are dealing here with wave-lengths so minute as to be almost inconceivable, yet their difference is visible to the naked eye – and not only

as a difference in hue. Thus in looking at a red-and-blue electric sign the red will seem nearer than the blue because of its longer wave-length, and consequently you will get a sense of depth. The farther away you are, the greater this effect. In the same way orange is a more "advancing" color than green, and green looks closer when seen on the same surface with violet. And many of us have seen the specially prepared pictures that, when looked at through a pair of glasses one of which is red and the other green, suddenly acquire the third dimension of depth.

Also, while the seven primary colors with their varying wave-lengths are the most easily discernible, it has been estimated that there are about one hundred and thirty different hues formed in the spectrum by the merging of one color into another, as reddish orange, yellowish green, greenish blue, and so on. But it is impossible to say at what exact point one color ends and another begins, so imperceptible is the transition.

We differentiate colors not only by their hues (i.e., red or green or blue), but also by their saturation (i.e., red or pink, light green or dark green) and also by their intensity (brilliance), which means that under the same light yellow will be brighter than blue and orange more distinctive than red. To such lengths have we carried out color specialization.

And not one of these colors can be seen without light. For *in the dark we are all color blind.*

At dusk we cannot tell the difference between a red and a green apple, or, if the current should fail, between a red and a green traffic light. On a rainy day your little red schoolhouse is not quite so bright a red; it appears grayish. At night it is nothing but a black blob in the surrounding gloom. For as light is reduced colors lose their identities and become dark nonentities.

But not all colors fade at the same time. If you should happen to be near a field of flowers at dusk, watch closely and you will see an interesting phenomenon. As the light fades all the red flowers will gradually turn gray and then black; then the violet, the blue, the yellow, and finally the green, in the

order named. Similarly, if the current is gradually reduced in a row of electric bulbs of equal size painted with the seven spectral colors, the red light will fade out first when seen from a distance and the others in the order named. With twilight or night vision, then, green is the brightest color; but in good light yellow is the outstanding color. Hence the popularity of yellow as a wall paint in the home. The same color-fading phenomenon is visible at nightfall in the home with your familiar colored objects around you. This difference in color disappearance was first noted by Johannes Purkinje, a Bohemian anatomist, and is named the "Purkinje phenomenon."

This apparently abstract scientific fact has long had practical application. Since, foot-candle for foot-candle, red is the least visible of lights, it follows that it is the least disturbing to dark-adapted retinal vision as well as all other types of light-sensitive chemical reactions. Hence for years photographers have been using a dim red light in their darkrooms for developing their sensitive films. In modern warfare, in convoys, airships, in bivouac and on maneuvers, where light would be a dangerous signal to the enemy, red lights are used when necessary because of their poor visibility.

Since we have said that the rods do our night seeing, and we know that they are not color-percipient, this talk of seeing colors at night — and we all do, of course — may seem somewhat confusing. Actually there is no contradiction. Let me make this a bit clearer: Whether we see color at night or not will depend simply on the amount of light. When a light of any color is so dim as to stimulate only the rods, no color at all is seen — only light. When the same light is made brighter until it stimulates the cones, then the color becomes visible. Hence visible color, day or night, is a function of the cones. And, concomitantly, color is a function of light. No light, no color.

The color of an object depends not only on light, but also on the *kind* of light by which it is illumined. Your favorite tie or dress may normally be a gorgeous red, but in a green light it becomes an object black and drab. The same would be true in a pure blue light. In similar fashion a blue object

looks black in red, orange, or yellow light, though it remains blue in white or blue light.

Those of you who have driven on roads lighted by yellow sodium lights will remember the ghastly greenish-black faces of your companions. The normal pinkish skin has been transformed into something strange and ugly by pure yellow light. This same principle is used in the theater to bring out certain designs of one color and to suppress others. In this way whole scenes may be changed simply by switching off one colored light and flashing on another.

It might be well to point out here that our world is made up, in the main, of two types of colored objects. The first type consists of those that are self-luminous, of which the most common example is the colored light. This is simply a light source surrounded by glass of a certain color. The light here comes from within the object itself. But by far the vast majority of colored objects are of the other type — the pigmentary. The color here depends on the external light around the objects. They have been correctly defined as substances that interfere with the whiteness of ordinary light. That means that they have the property of selective absorption and reflection. In ordinary light — and the sun is our best source of white light — these things vary in color because they absorb some of the wave-lengths which go to make up white light and reflect the rest.

And it is by their reflected light that ye know them.

Your suit is blue, your tie green, because these particular objects absorb all the other colors and reflect only blue and green respectively. Your black car, dinner jacket, and picture frames absorb all the light and reflect practically none, and hence they are black. White ceilings, shirts, and paper reflect all the light and hence are white, because *all* the light means white light.

But in a red or green light they would look red or green because there is no other light to reflect. The wide expanse over our heads that we call the sky is blue because dust particles high in the air reflect the blue end of the spectrum more than the red. As a result the sun looks red by contrast, espe-

cially at sunset, when it is nearer the horizon so that there are more particles in the atmosphere to reflect the red end of the spectrum.

The ofttimes-too-high collar on a glass of nut-brown ale looks white because it is full of air bubbles, which create so much increase of surface that the light cannot penetrate it completely enough to be absorbed. Hence it is reflected back to your eye as useless white foam, not as dark brown liquid. Colored soaps give white suds for the same reason. No doubt you can think of many other examples yourself.

Ordinary electric illumination is relatively yellowish, because it lacks some of the blue waves of the spectrum. Similarly, your blue suit looks black indoors because there is so little blue light to reflect. Fashion experts say that the apparently deepest black is the so-called midnight blue under artificial illumination. The woman buying a hat who insists on examining it by daylight may never have heard of the Young-Helmholtz theory, but from experience she has learned that the best way to gauge colors exactly is by the Almighty's outdoor light, not by man-made artificial light.

If colors did nothing but decorate our world and make it a more cheerful and interesting place to live in, their justification would be more than ample. We can all think of a hundred different ways in which they satisfy our esthetic sense.

But the selective reflection and absorption of light by pigments is no mere abstract if interesting scientific fact. Not only are colors decorative, but they also add in numerous ways to the comfort and safety of our lives. The use of colors as a protective weapon has been mentioned. The value of colored lights for efficiency and safety on land, at sea, and in the air, on machines and switchboards, is obvious. Color in industry, styling, furnishings, etc., hardly needs discussion here.

Science has given us the spectroscope, which depends on the fact that the light from every type of thing, however colorless it may appear, varies a little in color composition from that of any other type and is hence as individual as the skin whorls at the ends of your fingers.

It may smack of black magic to talk of invisible colors, but a good percentage of us have at one time or another worked miracles without thinking too much about it. Do you remember the colorless solutions in the chemical laboratory of your schooldays? They became red when a colorless acid was added, and blue when you poured in an alkali. Surely it is no exaggeration to say that these solutions contained invisible color. And it is fascinating to note how far ahead of us nature is. Millions of years ago, before we invented color indicators, nature was coloring the flowers that contain an acid cell-sap with red. Those with alkaline cell-sap are blue; those that are neutral in reaction are purple. Try it and see.

By spectroscopically examining light from the planets and stars we have been able to ascertain their composition and something about their structure. In medicine and other applied sciences the same method has been of tremendous importance as a help in analyzing many human substances. Recognition is facilitated by the spectroscopic picture. The conquest of disease has been materially aided in this way.

To come nearer home: It has been found that a room painted dark green or dark blue requires from four to six times as much light as the same room painted white or light yellow, because the darker colors absorb from 70 to 90 per cent of all the light, whereas the lighter colors absorb only from 10 to 30 per cent and reflect the rest into the room as useful illumination. This may not mean much in the shaded parlor, but in the kitchen, nursery, schoolroom, shop, and factory, where lighting is of paramount importance, it becomes an economic factor to be reckoned with. Not only does it affect the amount of current used, but there is also the fact that efficiency is dependent to a large extent on proper lighting. You have probably noticed, also, how much lighter the inside of a room is when the ground outside is covered with snow. This is because more than the usual light is reflected from the white ground into the house.

All this is important to you and me in still another way. The light absorbed, being radiant energy, is converted into heat. Hence a darkened room in the summertime not only

looks, but actually is, cooler. And the popularity of light-colored garments in summer and in the tropics is well deserved. Such clothing reflects away most of the light, and the wearer is therefore cooler. The expression "cool summer black" as applied to clothes is obviously a contradiction in terms.

The Amount of Light Reflected by Various Paints

COLOR	% LIGHT REFLECTED	COLOR	% LIGHT REFLECTED
White	90	Shell Pink	55
Ivory	80	Tan	45
Canary Yellow	75	Silver Gray	45
Cream	75	Dark Gray	25
Orchid	65	Olive Green	20
Buff	65	Brown	15
Sky Blue	65	Dark Oak	15
Light Green	60	Mahogany	10
Light Gray	60	Black	2

These figures are only approximate and will vary with the type, quality, and exact shade of paint used.

Almost two hundred years ago our own Benjamin Franklin proved this very fact by an interesting experiment. On a sunny winter's day he laid out squares of variously colored cloths on the surface of the snow. After a certain time he found that the darker the cloth, the deeper it sank into the snow. The lighter colored squares remained near the surface level, since the snow under them had hardly melted at all. Thus he proved to himself that light-colored clothing absorbs less heat and is therefore cooler than darker garments.

For a similar reason the air becomes colder as you go higher. Though the mountain peak or the airplane is nearer the sun, the atmosphere at high altitudes is clearer; there are relatively few dust particles to absorb the sun's heat and thus warm the atmosphere. If in the summertime we could sufficiently

purify the air close to the earth, we should be much cooler and more comfortable. Maybe that's coming next.

The phosphorescence or "cold light" seen at night on the ocean and the "fox fire" in the woods are due to the fact that the light rays absorbed by some tiny organisms during the day are not converted into heat, but are changed back almost entirely into light rays when given off. Hence "cold" light.

Another fascinating fact is that some colors bear a curious relation to others called "complementary." For instance, a pure spectral yellow light and a pure spectral blue light focused separately on the same spot will fuse to form white. But that only holds for *light.* When you mix yellow and blue *pigments* you get green, because blue pigment absorbs the red, orange, and yellow light waves and yellow absorbs the blue, indigo, and violet waves. Only green is left to be reflected.

This relationship of red to green and of yellow to blue works in still another way. Stare at a red light or any bright red object for half a minute, then close your eyes tightly or look at something white without moving your eyes. Soon you will experience a green visual sensation. The same is true of yellow and blue. You get what is called a complementary after-image. If the object first looked at is green or yellow, the after-image is always red or blue respectively, never any other color.

The ability of these particular colors to evoke each other is frequently used by color experts. If a dress designer wants a gray dress to have a warm reddish tinge, she trims it here and there with green. She also knows that neutral gray will tend to look bluish next to yellow and vice versa. Interior decorators are constantly using this principle of complementary colors to make rooms look cooler and warmer, larger and smaller; beautiful, cheerful, and inviting or drab and bare.

Asked what the most important colors are, I would unhesitatingly answer, red and green; and not only because they direct our traffic, though that is sufficiently important. Red is the color of hemoglobin, the important blood pigment of all backboned animals, of which we are presumably the highest example. And green is the color of chlorophyll, the im-

portant pigment of all growing things and therefore the most universal of all colors. Without these two pigments life on earth would be impossible, since plants are the ultimate source of all our foods, and blood is the life-giving fluid of our bodies. In some of the shellfishes, much lower in the evolutionary scale than we are, the blood pigment is not red, but blue. These are the true blue-bloods of the animal kingdom.

On the other hand red and green seem to be the most vulnerable of our color perceptions. As we have seen, most color blindness is of the red-green variety. In certain diseases of the eyes due to excessive use of alcohol and tobacco, poisonous drugs, syphilis, typhoid, and malaria, and in degenerative diseases, one of the earliest signs of trouble may be red-green blindness. If the trouble is still more severe, perception of yellow and blue may also be lost. In particularly severe cases all color vision is lost.

We have also seen how we all become color blind in the dark. Another way is by the simple process of growing old. With the years the crystalline lens inside our eye becomes somewhat brownish, and gradually our perception of blue and violet is weakened because these colors are filtered out somewhat by the brown lens. All white objects acquire a slightly brownish tint, too. In most cases this is of little consequence. But it is of great importance to artists, industrial painters, and all those to whom a fine color discrimination is necessary. For the tendency here is to fail to see the fainter blues entirely. Painters who sense their deficiency sometimes tend to overload their compositions with blues, like the deaf man who shouts because of his own bad hearing.

We are sometimes inclined to be discouraged with our world as it is. Nor can it be denied that there is much in the prospect that is dark and gloomy. But it is not all drab. As long as cowardly yellow and black despair can be routed by the red badge of courage and true-blue steadfastness, our world can never be drab. There are too many colors in it. May they never fade.

VII

Through Colored Glasses

The chances are two to one that you own a pair of sunglasses, and ten to one that they are not suitable for you. These estimates are conservative.

Time was — twenty, even ten, years ago — when tinted lenses were worn mostly for "weak" or ailing eyes. They were a novelty, calling for laughter or sympathy according to the kind of friends you had. Those days are over. Now violently colored goggles frequently decorate our faces, and nary a comment do they evoke. They are standard vacation and sport equipment for camping, fishing, hunting, and hiking. From early spring to late fall and sometimes the year around they brighten the workaday lives of our general citizenry on city streets and country lanes.

Although of recent popularity, colored glasses have been known to man for a long time. It is believed, for instance, that as far back as two thousand years before Christ semi-precious stones of various hues were used by the Chinese to protect the eyes from sun and glare. A more certain historical fact is that fragments of colored glass have been found in excavations of ancient Egyptian tombs. Whether tinted lenses were used there is not certain, but they did have the makings. From then on until quite recently we hear little of colored lenses except for the few gestures made by quacks in the Middle Ages to cure disease with lenses of various colors.

Early in the twentieth century Sir Isaac Crookes perfected the infra-red and ultra-violet absorptive lens that bears his name. This was the first lens made to specifications for the purpose of keeping out harmful light radiations from the eye. At first its use was limited to the industrially hazardous oc-

cupations. More recently its adoption for everyday use has increased tremendously.

It has been estimated that forty million pairs of good, indifferent, bad, and just plain terrible sunglasses are sold in this country *yearly*. Those in the first class comprise a trifling fraction of the total – probably less than 10 per cent. And by good I do not mean expensive; these terms are not synonymous, as you shall see.

There are persons – I am not one of them – who feel that this demand for colored cheaters is a fad, a passing fancy sure of an early if colorful death. Perhaps. But if this is true, at least it is one of our saner fads, because, when properly used, sunglasses make sense. This is why:

On a bright summer day the sun from its position millions and millions of miles away delivers at least 10,000 foot-candles of light to us here below; sometimes it is more than that. You begin to get some idea of what this means when you realize that our artificial indoor lighting, under which most of us spend our lives working, playing, and relaxing, is usually substantially less than 10 foot-candles. Add to this the fact that so many of us have eyes needing help in the way of corrective lenses, and you see why proper protection from glare and from too much light may be beneficial for eyes not accustomed to such conditions.

An objection here is, "Well, what did we do before colored glasses became so popular? We seemed to get along all right then." True, nature has given us a marvelous seeing mechanism that in most cases works efficiently under the bright noonday sun and in deep twilight. The efficiency reserve of our eyes is so great that our visual ability can be stepped up or down a millionfold when necessary. Many of us can and do get along without light protection. But this does not mean that we do not feel better and more comfortable when our eyes are not pushed to their utmost. There is a world of difference between being able to "get along" and doing so with a maximum of comfort and efficiency. The question is not how well we can get along without sunglasses, but whether we are better off with them. Many find that such glasses are an aid

and a comfort. Moreover, thoughtful patients are beginning to ask other pertinent questions:

1. *When should sunglasses be worn?*
2. *What color of lens is best?*
3. *How dark should they be?*
4. *Do they ever hurt the eyes?*

With the use of tinted lenses as a protection against the elements and inquisitive eyes constantly increasing, the answers to such questions become important.

Generally speaking, sunglasses should be worn to protect the eyes when there is too much light and glare. To most of us this means out of doors, usually in summer, at the beach, on the golf course and tennis court, motoring, fishing, hiking, and the like. Even in the city old Sol's rays may be so powerful as to require dilution on the unshaded street.

How about the color? Well, frankly, it makes very little difference. It has never been proved scientifically that there is sovereign virtue in any one color. The important thing is to furnish the protection that the eyes need and should have against the overwhelming amounts of light reflected from sand and water and sidewalk into the sensitive retina. This protection is obtained by the mechanical screening out of light when there is too much of it. All colored lenses do this if sufficiently dark. So milady may wear whatever colored lens suits her fancy or blends with her costume.

Of much greater importance than the *kind* of tint is the *depth* of tint of sunglasses. *They must be sufficiently dark.* This (Question 3) cannot be overemphasized. The ability of a lens to keep out unwanted light depends directly on the depth of its color, whatever that color may be. Many sunglasses are too light to be effective.

To be of any value in bright sunlight sunglasses should be dark enough to keep out at least half of all the light. While frolicking at the beach on a bright July or August afternoon you can dispense with ninety per cent of the light with complete comfort and safety to the eyes. Hence lenses which under such conditions keep out only ten, twenty, or thirty

per cent of the light are better than nothing, but not much. And those in which the tint is scarcely visible are no better than ordinary window glass in counteracting glare.

Tinted lenses are usually sold in four shades marked # 1 to # 4 or A to D, ranging from lightest to darkest. For outdoors, those marked # 3, # 4, C, and D are suggested.

Nor – Question 4 – do tinted lenses have any permanent detrimental effect on the eyes. They do *not* cause color blindness. Tests performed on individuals who have worn colored glasses for years showed no impairment of color vision. Sporadic cases of transient loss of accommodation – i.e., loss of ability to see near objects clearly – have been reported. But these are extremely rare and always temporary. Furthermore, this can always be avoided by taking the glasses off for short rest periods during the day. No, there seems to be no foundation for the belief that the prolonged wearing of tinted lenses will cause permanent injury to the eye.

Several other points are of interest to you and me. The question of the effect of tinted lenses on color values crops up from time to time. It must be stated flatly that there is no sunglass of any appreciable hue which does not affect the colors of objects somewhat. A study made by the National Bureau of Standards of the U. S. Department of Commerce proves this. The true *neutral*-colored lens simply does not exist, because some colors must be absorbed more than others by a lens of any tint. If the tint is very faint, colors are not altered substantially. But all colored glasses, when sufficiently dark to be effective against glare, show a selective absorption by tending to blot out some colors and accentuate others.

I hate to break a long-cherished illusion, but to don a pair of rose-colored glasses is not the best way of seeing a beautiful world; and the rosier the glasses the less rosy the view. If sufficiently red, they will change cheery greens and yellows and blues to dreary gray or funereal black. Dark green lenses on the other hand, will absorb everything but green and are especially dangerous because they blot out the red of the traffic stop-light. The darker amethyst-colored lenses tend to absorb greens and blues, leaving yellows, oranges, and reds

comparatively intensified. The bluish-green lenses tend to absorb red and blue and accentuate natural green. Smoky greenish-yellow lenses are popular among aviators because they tone down the bright blue of the sky. There is also some reason to believe that these lenses help long-range visibility by eliminating the blue haze of the atmosphere, which is caused by the scattering of the short blue and violet components of light.

In brief, wearing tinted lenses is the same as lighting your world up — or down — with the color which your glasses happen to be. Hence when the discrimination of colors is of great importance it is better not to wear tinted lenses at all. If they must be worn, the neutral gray smoky tints (the darker shades look almost black) have been found to have the least effect on color relations, though even here there is some change.

Another point: Modern science has focused a great deal of interest if not light on infra-red rays, ultra-violet rays, actinic rays, cosmic rays — an infinite variety of rays that age increases and custom popularizes. To combat their supposed malignity enough variously hued lenses to outrival Joseph's famous coat have been brought out. Faced with such an array no wonder many of us are somewhat bewildered and keep asking what color is the "healthiest" for the eye.

The infra-red and ultra-violet rays have received the most publicity and seem to cause the most concern. Especially have misunderstandings arisen concerning the connection of these rays with too much light and glare. Undoubtedly infra-red and ultra-violet rays are injurious when the eyes are indiscriminately exposed to them. Since these rays are invisible and therefore of no aid to vision, the wearing of glasses to screen out these offending rays is quite all right. But it should also be clearly understood that, being invisible, infra-red and ultra-violet rays have nothing to do with glare. Glare is caused by concentrated *visible* light rays that are not sufficiently diffuse — "light in the wrong place," it has been called. It obviously cannot be caused by rays that are invisible.

There are conditions under which these mysterious little waves of energy become dangerously important. Thus, in

such specialized industries as acetylene-torch welding and glass-blowing they are of unquestionable hazard, and protective goggles are imperative. Certain types of cataracts found among glass workers are believed to be caused by infra-red rays given off by the heated glass.

If you are fortunate enough to spend your vacation skiing over vast expanses of white snow, the reflected ultra-violet rays may cause annoying though transient pinkeye. Protective glasses to prevent this should be worn. In looking at an eclipse of the sun with its injurious infra-red rays the naked eye should never be used. It should be dressed for the occasion in proper absorptive lenses. And under the various types of patented sun-lamps that give an artificial Florida tan they should not be forgotten.

Infra-red rays usually give advance notice by causing a burning sensation in the eye and can thus be guarded against in time. But ultra-violet rays give no sensation until several hours later, and hence are more insidiously dangerous. (This, incidentally, is why you do not feel the full effects of your sunburn until you get home at night.) The darker shades of sage-green and bluish-green tinted lenses seem to offer the best protection for all these purposes and are used as standard by the U. S. Government in some of the services. Many other types of good lenses are sold for this purpose, and any reliable optician will be glad to help you with your selection. Get the lenses dark enough.

Now that all this has been said, however, it is also comforting to know that these rays, although theoretically a hazard, practically are of secondary importance in most of our outdoor activities. In large cities and their environs, especially where a smoke pall is present, the atmosphere acts as a filter to keep out most of these rays. It is only in the higher rarefied atmospheres and under special industrial conditions that they need cause us any concern. In most cases any pair of ground and polished glasses, sufficiently dark, will do.

The most important safety step against too much light and glare is the correction of all visual errors of the eye. Instances of eye fatigue on long automobile drives are on record where

even the darkest glasses were ineffective. When the needed colorless corrective lenses were worn they did away with the discomfort. Those who need all-time glasses for good vision may have their prescription ground into dark lenses of sufficient opacity to be worn outdoors only. Or a dark pair of slip-ons may be obtained that will hook on to the front of your regular glasses and can be removed indoors. They are a little bulky, but quite practical.

Occasionally a question is asked about the lenses used to counteract polarized light. It should be remembered that the only polarized light we have in nature is that reflected from a bright surface, as from the hood of your car by the angled rays of the afternoon sun, from an oily road, a smooth body of water, or an expanse of snow or ice. Hence against *reflected* light these lenses are advantageous. But against the *direct* rays of the sun they have no advantage over any other tinted lens of the same shade.

Very cheap sunglasses are a false economy. These inferior grades contain imperfections that may make you artificially nearsighted or farsighted or astigmatic. Or, with complete impartiality, they may make you nearsighted in one eye and farsighted in the other. Their surfaces may be so irregular as to give you the impression of looking through a rain-swept windshield without the wiper. Glasses made of plastic materials are the worst offenders in this respect. The effort to see clearly through them may have a tiring effect on the eye and may cause headache and eyestrain, just as wearing the wrong glasses does under any circumstances. This defeats the purpose for which they are worn. The fact that such glasses are frequently tolerated only proves the remarkable qualities of the long-suffering human eye as a functional, adaptable organ.

Ground and polished sunglasses need not be too expensive. Good ones, in all colors, can be bought for a couple of dollars or less. Once bought, they become a permanent investment. Before buying them test them yourself as described in Chapter V. A good, well-ground lens will not show the slightest movement of the object looked at through it when the glass

is moved about. If there is the least movement the glasses are imperfect and should be rejected.

Of recent years many have taken to wearing prescription lenses that are slightly tinted. When asked why, they are not quite sure. Frequently they were recommended for "softening the light." Another reason – more understandable – is that they "look better." Some have heeded the commercial injunctions to wear them in order to "eliminate haze," to lessen "veiling glare," to reduce chromatic aberration, and to cut out "peripheral overbrightness," whatever that is. It would seem as if all one has to do to avoid the Sturm und Drang of modern living and looking is to wear restful tinted lenses. Since they cost more than the colorless prescription lenses it is assumed that they must be better. In the words of the song, it ain't necessarily so.

If all these were serious hazards, none of us would dare expose the naked eye to that universal evil, light, without muttering an incantation or two. And we should all creep around the world like moles, darkly bespectacled. This is exaggerated, of course, but it is rather absurd to find that in most instances the lenses worn to avoid all these evils are so faintly tinted that the color is practically unrecognizable. Such glasses do no harm and also little good.

We have seen that the normal eye is a highly adjustable organ possessing a large safety factor for extremes of illumination. It is built to work this way. To argue that it needs glasses that keep out less than ten per cent of the light – and that is all the lighter shades do – is to ignore many well-known facts at our disposal. To assert, as some do, that tinted lenses are necessary for a large portion of the population indoors, because the usual tendency nowadays is to overlight both home and office, seems to contradict the conclusions of most of the reliable investigators.

Some persons – fortunately no more than a few – have got into the habit of wearing deeply tinted lenses all the time – day and night, indoors and out. It is no deep secret, for instance, that ladies will occasionally wear dark glasses to hide the crow's feet that are so stubbornly resistant to prayer,

blasphemy, and massage. Their adaptable eyes grow accustomed to dim illumination, and then even normal amounts of light become objectionable. Though not permanently damaging, it is a rather silly habit to get into. Only rarely is it justifiable.

That there are persons who need to wear tinted lenses most of the time goes without saying. Albinos and very light-complexioned folk with little eye pigment to absorb excess light find them a comfort. A few have been found to be allergic to light and are entitled to them. When the eyes are inflamed or diseased dark glasses are necessary. And their use in industrially dangerous occupations has been mentioned. But constantly to subject the normal eye to this insidious habit is to deprive it of light that it needs and should have.

Our eyes are made for light – plenty of light. But, as in almost any other province, you can have too much of the good thing. Tinted lenses find their primary legitimate use for most of us when there is too much light for the normal eye or when a normal amount of light is too much for an abnormal eye. All else is vanity.

VIII

The Eye Muscles

A SHY little woman sidles into the clinic. She has a good firm grip on a sulky nine-year-old boy who is obviously not there of his own volition. The mother is worried and bewildered. It seems that the child had measles five years ago and became cross-eyed. Kind friends told her that the boy would grow out of it, but he never did. And now his eyes are worse than ever.

The mother's English is somewhat obscure, but her anxiety and her son's cross-eyes are quite obvious in any language. The child not only has a permanent eye difficulty, but has also developed a permanently evil temper. He is unsociable, stubborn, and much given to fighting with other boys. It is sometimes hard to convince the mother that her child's behavior problem is due to his eyes. The stigma of "cockeye" embitters a child's whole life. He may fight back, as in this case, or he may become a shamed, slinking youngster, always avoiding his playfellows. The detrimental effect on a little girl's life is just as marked.

The same story in many different dialects and often in the most refined of accents is told over and over again daily in the eye physician's office and clinic. It always deals with young Tony or Sammy or Mickey or Algernon or their little sisters. Sometimes measles or scarlet fever or pneumonia was the cause; sometimes there is the story of a bad fright. Often the cause is obscure.

Too often the mother waits until it is too late to do much good. It is so much easier and pleasanter to believe that the child will "grow out of it." He may. But the chances of his doing so are so slim that any mother who neglects to consult a doctor when the cross-eye is first noticed, and who waits trust-

ingly for the eyes to straighten themselves, is usually condemning her child to a life of permanent disability.

The cross-eye or squint, as the eye physician calls it, may be due to one of many causes. Basically it is due to something that has caused the eye muscles to work too hard or has prevented them from working hard enough.

All of us remember being taught somewhere in grade school that there are six tiny muscles attached to each eye, which move the eye and keep it pointing in the proper direction. They are so skillfully attached above and below and at each side that the eye can move easily in all directions and can even rotate on its own axis. No ball-and-socket joint made by man works so smoothly. By means of the brain, the nerves supplying these muscles are hooked up with our other senses in such a way that if we hear or smell or feel anything requiring attention the eyes automatically move in the proper direction.

And they move as a team. Even if one eye is closed or covered, if we look in a certain direction, both the open and the occluded eye move together; so that if we want to be sure that one eye is kept absolutely quiet after an eye operation, both eyes have to be bandaged. The object of this yoked movement of our two eyes is to give us, willy-nilly, the images of both eyes simultaneously. Our eyes, therefore, not only move together, but also *see* together, and the two images which they receive separately are fused by the brain into one. As we have previously seen, this is the binocular vision and fusion of which we are the highest exponents.

But it is this same highly prized fusion faculty of ours that is often the cause of eye trouble; for anything that interferes with it also disturbs the smooth teamwork of the two eyes.

At birth the eyes of the infant may turn in or out or up or down separately, like a couple of loose headlights, because the fusion faculty is not yet fully developed, and there is no reason for the child to use both eyes together. This is especially noticeable if the baby has an upset stomach or some other disturbance. It should cause parents little worry. But if it continues after the first six months of life, especially if it

occurs with increasing frequency and lasts more than a few moments at a time, it should then receive attention. Such eyes may become permanently crossed unless treated properly and early.

One of the important causes of cross-eyes is an inequality of the two eyes. This is one of the worst visual enemies of young, growing children. Very few of us are born absolutely symmetrical. Careful measurements will disclose differences in our arms and legs and in the right and left halves of our faces and bodies. You know, for instance, that one new glove or shoe always fits a bit more snugly than the other. In similar fashion the difference in our two eyes may be pronounced.

This asymmetry is bound up with one of the most common types of cross-eye or squint. I do not mean the relatively infrequent immobile eye due to paralysis, but the much more common case in which the eye can move to any position but chooses to stay in one – the wrong one. Mother Nature works in wondrous ways, but not always to perform beneficent miracles.

Given two eyes of markedly unequal vision, one eye with good vision and the other poor, the composite picture formed by the fusion of the images is vague, since the image in one eye is so poor. Fusion is impaired. The child will gradually tend to use the better eye to the exclusion of the poorer one. The worse eye, lacking the stimulus of constant use, at first will not try to see and later will forget how to see. It has become the "lazy eye" that you have heard about. Fusion is lost.

Another reason for the suppression of sight in one eye is to avoid annoying double images. Since in cases of squint the eyes are often too near or too far apart to be able to focus and fuse the same object easily, the child is often troubled with double vision at first. But it quickly learns not to see or to "suppress" the image in one eye, again giving a loss of fusion.

Such a child is no longer a binocular animal. The two-eyed team has been broken, and to all intents and purposes little squinting Johnny or Mary now has only one eye. Not only that, but the non-seeing eye, having no reason to point in any particular direction, tends to wander in or out by itself, and

the result is a cross-eyed youngster. Many who today cannot read as they run, as a result of such a handicap, might have been spared this permanent infirmity had they been treated properly in childhood.

The chances are that a good proportion of the people you meet in the street with cross-eyes not only have eyes that are not straight, but also have one eye that cannot see well. And right here let me say that one of the most curious phenomena in eye practice is the number of adult, intelligent patients one sees who have markedly reduced vision in one eye without knowing or suspecting it. If you think this is far-fetched, let me ask you (unless you have already been forced to have an eye examination) whether you have ever thought of closing your eyes alternately to check up on the vision of each eye separately. Don't be chagrined: few have. We sometimes carry our lack of observation to remarkable lengths. And if this is true of adults, it is doubly true of children. No wonder so many squints are not seen in time.

Another important cause of squint is our old friend the refractive error — nearsightedness or farsightedness. The child with the "internal" or convergent type of squint, whose eyes are perpetually trying to approach each other, may have normal vision, but the chances are much better than even that it is farsighted. Such a child must constantly strain its eyes or accommodate in order to see the nearer objects clearly. And it is this constant effort that causes the eyes to turn in.

On the other hand, the wall-eyed child with the "external" type of squint, whose eyes seem to be trying to get away from each other as far as possible, is frequently a nearsighted child. Such eyes are focused for near objects only, as we have seen; they may be so nearsighted that there is not the slightest necessity for them to accommodate and converge. As a result the too-relaxed eyes may turn out, thus again giving us a squinting child. This kind of squint usually appears later than the "internal" type.

There is still another class of squint that has not been mentioned. This includes those cases, rather frequently found among children, who despite good vision, usually equal in

both eyes, seem to have no fusion. For some reason not quite clear as yet, the fusion faculty has never properly developed in these children. These are the so-called "alternating squinters," who play no favorites but cross first one eye and then the other with complete impartiality.

Most of the cross-eyes in children fall into the above categories.

Other less frequent causes are direct injuries to the eye muscles, at birth or later, that paralyze them and make them unable to perform their proper function. The defect may also be due to some faulty development of the muscle or of the nerve supplying it for which we know no adequate reason. It may be caused by some of the acute diseases mentioned earlier, or, later in life, it may be due to syphilis or other infections.

Heredity is believed to play a rôle in the development of cross-eyes. It is not rare to see families in which one parent and several children look at the world through a perpetual squint. In these cases we feel that it is not the cross-eye itself that is inherited, but the underlying causative factor; that is, the nearsightedness or farsightedness has been handed down to make the child's early life more difficult.

Cross-eyes are not always of the horizontal variety, in which the eyes are either too near each other or too far away, although this is the most common type. Occasionally one eye is higher than the other, because of weakness in one of the vertical muscles that pull the eye upward or downward. In such a situation the image of one eye will be higher or lower than the other. In an effort to avoid seeing double the child may acquire the habit of tilting its head to one side in order to bring the images of the two eyes closer together. If unsuccessful, here also it may learn to ignore one of the images and, as before, forget how to see with one eye.

On rare occasions such cases have been confused with wryneck and have been treated for a postural instead of an eye defect. Hence all children with disturbances of head posture should receive a thorough eye check-up.

Whatever the cause, the cross-eye in an older child or adult

is usually the hallmark of neglectful, careless parents. Nowhere is the biblical phrase about the sins of the parents visited on the offspring more applicable. These are the sins of omission. A good proportion of these children can be cured of their squints by conservative measures if treatment is started early enough and persisted in long enough.

The cross-eye may develop soon after birth. More commonly it appears in the second, third, or fourth year of life. It does not go as easily as it comes, and it is *when it is first noticed* that help should be sought. Later is frequently too late.

The child may need nothing but properly fitted glasses to straighten its eyes. If there is defective vision in one eye only, medical attention for the poorer eye as well as glasses may be needed to prevent permanent loss of vision. The physician may order the *good* eye to be covered with a patch or may put drops into it so that the vision is temporarily blurred. This forces the poorer eye to do all the seeing necessary, and thus its functional activity is stimulated and its ability to see improved.

Where such methods are ineffective, a minor operation on one or two of the eye muscles usually sets the eyes straight. Then fusion training may be instituted. The fear of operative procedure is a needless one. The operation here is on the external muscles of the eye, not on the eye itself; in no way does it interfere with the visual function of the eye.

Muscle exercises, called orthoptic training, may be of value, especially in attempts to restore fusion where it is absent, also before and after operative procedure. Not all kinds of cross-eyes are amenable to such treatment, and the reports and opinions of eye physicians vary as to just what percentage of cure may be expected. Undoubtedly, however, there are many cross-eyes which can be helped by a regimen of controlled exercises.

The best chance for the success of orthoptic training is before the age of six or seven — before the child's faulty eye habits have become too ingrained and before the child begins to go to school and put its eyes to strenuous use. And the

earlier the treatment is started the better. It has been found that during these first formative years the eyes have not yet attained their full faculties and are therefore more malleable and more responsive to treatment than after they have become "set."

At the age of seven the eye has usually grown to almost its full size; its function is fully developed; and the possibility of restoring useful vision to an amblyopic (poor-visioned) eye after this age decreases rapidly. It may still be done, but the chances are much slimmer, and the results in many cases are only partial. An eye can almost always be straightened cosmetically – even in the adult – but vision cannot be restored. It must be done early.

There are some children who begin to wear glasses before the age of two. This is not too young. Some of these may be able to discard their glasses later because they received skilled care at a sufficiently early age. If this care is given soon enough, moreover, an operation may be avoided. And, most important of all, the child will be spared much unhappiness.

Thus far I have spoken only of the cross-eye; i.e., that abnormality of the eye muscles that results in failure of the two eyes to point in the same direction. This occurs most commonly in the young and as a rule is painless.

There is another type of eye muscle deficiency, much less spectacular, that is especially troublesome as we get older. I am referring to those cases of weakened eye muscles in which the trouble is not quite severe enough to attain the dignity of a frank cross-eye. These are called "phorias" by the eye physician. They lie in wait, ready to pounce and destroy our comfort.

Here again it is our vaunted binocular vision that is the root of the difficulty. The very advantages that we enjoy over the lower species prove a source of pain and discomfort. A weakened muscle means additional strain in order to maintain that nice balance necessary to comfortable vision. But strain is not conducive to comfort, and the result may be headache, a short victorious temper, and a long, losing battle with the eyes until a physician is consulted – all this with excellent vision.

Make no mistake about it, it is possible to have excellent vision and suffer with the eyes.

In reality these are cases of latent or hidden cross-eyes in which we manage to keep the eye straight by a special effort. This cumulative, continuous effort often results in a severe type of eyestrain indistinguishable to the sufferer from the symptoms of an uncorrected refractive error.

A common source of trouble is the muscles that pull our eye inward. When we look off into space our eyes are normally straight and parallel. In looking at things near us our eyes have to converge, more and more the nearer the object. Many of us work at a desk or work bench all day with our eyes constantly converged on something close at hand. Sometimes the little inward-pulling muscles give out under the strain, and we soon know about it. Reading or any sort of near work becomes a painful procedure if not an impossibility, because of the greater muscular effort needed to keep the eyes in place. Car-sickness and dizziness may sometimes be chargeable to the same source, because of the additional effort necessary to focus on rapidly moving objects.

When the sufferer is finally forced to seek advice, the story is usually the same. "But, doctor, I can't understand it. I've always had such good eyesight." That may be true; but it is not poor vision, it is poorly controlled vision, that is at fault here. Such a patient, in his thirties or forties, is beginning to lose the young, vigorous constitution that helped him to ignore minor infirmities in his youth. Approaching age has left its handwriting on the wall, but he cannot see it so easily any more.

Here again the trouble may be a weakening of the muscles that pull the eyes outward, upward, or downward as well as inward. In all such situations the job of keeping the eyes working together becomes a burden. Such cases are not rare; they are seen daily.

When the muscles are especially weak a frank cross-eye may occasionally appear, to disappear when the eyes are rested again or after a night's sleep. Fatigue is also the explanation for those cases of periodic squint in children where

the mother notices the cross-eye only in the evening, when the child is tired after a long day of school and play.

Many who have such muscle weaknesses may go through their entire lives symptomless because their deficiencies are mild enough to be easily controlled or because the type of work done does not put the weak muscles to much strain. In others the signs may appear at any age from six to sixty and beyond. They may become apparent during the early school years, but usually not until adult life, when the demands on the eyes are increased enormously. Sometimes they appear as the result of long, debilitating illness. Most often the disease is simply accumulated years.

But no matter what the age, these muscles require and, indeed, cry out for help. This consists of glasses properly fitted to take all the strain possible off the eyes. It may also include exercises to strengthen the weak eye muscles. Sometimes the condition is so severe that prisms have to be incorporated into the glasses. A prism is a wedge-shaped optical glass so ground as to deflect light rays from their natural course in any desired direction. In this way the images of the two eyes are either separated or brought closer together, fusion is attained, and the weakened muscle relieved. The device is just another crutch for the weak eye – an invisible crutch, for such glasses are usually indistinguishable from the ordinary prescription glasses.

Not all eyes can be helped, any more than vision can always be restored. There are some hopelessly diseased or congenitally defective eyes for which little can be done. But in the majority of cases much can be accomplished if patients will get help early enough. In the bright lexicon of youth – and old age – we have too many needlessly unhappy, cross-eyed, and dim-eyed fellow beings.

IX

Light by Man

The eye, an organ adapted for light, is at its maximum efficiency in the dark. This is more than an interesting paradox. It is a physiologic fact of great social and economic importance for all of us. It did not mean so much to our early ancestors, who lived and had their being by the sun. We do not and have not.

Early man's requirements of artificial illumination were few and easily satisfied. Until quite recently fire in its various forms was the universal source of artificial light. The early descendants of Adam used torches made of resinous woods and oily vegetables to light their meager night activities. The oil lamp, thousands of years old, marked a long step forward on the road to modern lighting. This was followed by the wax candle of the Phœnicians, a comparatively recent development as time goes. Then the tallow candle and finally the paraffin candle of only one hundred years ago lighted the progress of man up through the ages.

The Chinese were probably the first to use natural gas, which they piped through bamboo tubes from their salt mines. Following this, gas illumination went through various evolutions, and many readers will still remember the old Welsbach gas mantle that lighted their homes.

Meanwhile other important investigations and experiments were going on. Man was not satisfied with his illumination. Nature's daylight, abetted by the relatively crude artificial light sources in use, was proving insufficient for his constantly widening activities at work and at play. As far back as 1752 Benjamin Franklin started us on the road to electrical illumination by discovering the true nature of lightning with his now famous kite experiment. And by 1820 a man named De la

Rue had already conceived the idea of an incandescent electric lamp.

Numerous other experimenters were working on this problem, each making a small contribution and taking a step nearer the solution. But it was not until Thomas A. Edison in 1879 gave his famous exhibition of an incandescent lighting system at Menlo Park that artificial illumination finally stepped forever out of the age of fire and into the age of electricity.

Edison, though the idea of an incandescent lamp was not original with him, was the first to combine and improve the various elements necessary to produce a stable electric light source that could be easily and dependably used for all occasions. Since then the electric light has been improved by others until its efficiency is twenty times that of the original. But it is to Edison that the credit for the invention belongs. From the blazing glory of Times Square to the feeble glow of the hospital night lamp, the incandescent light is his creation.

It is less than fifty years since electricity has become available as a general illuminant, and it is still far from universal. Flame is still the only source of light for more than half of the world's inhabitants. In this country we are fortunate. We now use nearly a billion electric bulbs a year — as much as the rest of the world put together — to light up our nights and days.

It is not necessary for us to be playboys who "rise with the moon and go to bed with the sun" to be dependent on artificial illumination these days. Most of us burn the candle — an electric candle — at both ends, because we cannot help it. In school, office, factory, hospital, and home modern conditions force many of us to work during the day and to relax at night under man-made light. Air and light are still free, but real estate has become a much more valuable commodity than it was in the days when the original Americans roamed the plains, and, especially in our urban communities, buildings are erected so close together that the daylight is squeezed out between them. Even in the more sparsely settled areas our ordered, time-tabled existence has forced us to counteract the

variables of time and weather and light by shutting our manufacturing and commercial activities into shelters in which light and temperature are artificial and hence more constant and dependable. If a shipment of bombers is due on a certain day, the weather must not interfere with the schedule — even if daylight is better and costs nothing. An "act of God" such as a dark, cloudy day does not upset our routine any more.

But along with these numerous advantages we have also acquired some bad lighting habits. Many of our homes are lighted for beauty, not utility. We not only obscure our windows during the day with dark shades and drapes, but at night we make them cozy and romantic and artistic and "interesting" — and not very habitable from the standpoint of lighting.

In our schools the story is the same. Medical literature is replete with reports of inadequate lighting. A recent exhaustive study made at several of our large Eastern universities showed woefully inadequate lighting facilities in library, dormitory, laboratory, and classroom under both daylight and artificial illumination, especially the latter. Surveys of factories, hospitals, and office buildings show the same thing and report increased efficiency and well-being with improved lighting conditions.

It must not be inferred from this that things were better in earlier days. On the contrary, they were much worse. None of us would like to read and study by a wood fire as Abraham Lincoln did. But, comparatively, there was much less done at night or under artificial illumination by day in the long, long ago. We must carry on a thousand and one intricate manipulations, do calculations, read millions of letters, and push our eyes over yards and yards of printed lines — all by indoor lighting. The nature as well as the volume of the work we do under artificial light puts an infinitely greater strain on our eyes today. For many the night hours are now important in earning a livelihood. To many more it is the period of play and recreation after the daily grind. Illumination by man has helped stretch our day into night, and many of us begin where our grandfathers left off.

On the whole there is no objection to this, because our eyes can "take it." Luckily for us, as we have seen, they have efficiency reserves that can be stepped up tremendously to meet environmental requirements of wide variation in intensity of illumination. It is true that we of this day are constantly drawing on these reserves; but that is what we have them for, and they are standing up pretty well under the strain.

For some years now eye physicians and illuminating engineers have been studying the effect of prolonged artificial illumination on the human eye. Obviously this is of the greatest economic importance to millions of workers in office and factory. The subject is new, and much remains to be learned. But as far as we can tell now there is no evidence to show that the prolonged use of man-made light has any detrimental effect on the eye – when the light is adequate. Or, to put it another way, the chief objection to the prolonged use of artificial illumination is not that it is harmful in itself, but that it is usually inadequate and fails to approach daylight illumination. It was shown, for instance, that before 1930 English miners suffered greatly with their eyes. When illuminating conditions were improved, eye complaints decreased by more than two-thirds. Such examples are numerous.

It seems, therefore, that we can work our light-adapted eyes in comparatively minimal illuminations with no apparent damage to most of us, provided we do not push them beyond their capacities with the wrong kind of illumination. *Now what is the right kind of light?*

Physicians agree that light must be "good" both quantitatively and qualitatively. The amount of light necessary for the human eye is a subject that has been debated long and far and loud. It would be fine if a fixed, clear-cut standard of illumination could be set for all. Some are trying to set it; but the attempt will not work, because the human eye is not that way, and neither is the human being. Both eyes and people refuse to be typed. Nor is the same eye in the same human head always the same.

First, as to the quantity of light: In 1897 a man named

Konig investigated this subject and found that visual power increased markedly from zero to 10 or 12 foot-candles of light intensity and that for practical purposes there is no appreciable benefit to good visual acuity beyond the 16-foot-candle level. During the course of his experiments he also found that an increase of twenty million times in light intensity only gave a twentyfold improvement in vision. None of the more recent studies seems to have disproved these conclusions.

Based on this work and on that of more recent investigators, the consensus of opinion now seems to be that a good norm for the average eye is about 12 foot-candles of light. (The reader is again reminded that "norm" and "average" as used here are elastic terms, subject to a good deal of stretching. But we must have some basis on which to start our discussion.) This means that most of us can work at our daily occupations under this amount of light with comfort.

Now, 12 foot-candles is approximately the amount of direct light given by the ordinary white frosted 40-watt electric bulb *with a good reflector* at a distance of 24 inches. This is increased to 20 foot-candles if only 18 inches away. The same 40-watt bulb in a plain bridge lamp (without a reflector) would only give you about 5 foot-candles when 18 inches away and 3 foot-candles at 24 inches away. The distances given here are much nearer than the usual position of the lamp from the user in the average home.

(The term "foot-candle" comes from the old-fashioned sperm candle of definite size and weight originally used as a standard. We now use an electric lamp of the same intensity so standardized that the same amount of light can always be reproduced accurately.)

If a 100-watt white frosted bulb is used, it would give only one foot-candle of light 10 feet away and 20 foot-candles if one foot away. The strength of light, you remember, decreases as the square of the distance; so that there is nine times as much light present one foot away as three feet away from the same light source. Evidently it is not enough to have a "strong" light. It must be near enough for us to profit by it.

Of course, the 12-foot-candle standard is a norm that is

abnormal to many. Those in their late fifties and sixties may require ten times as much light as the ten-year-old for good vision. For exceedingly fine work such as engraving, drafting, and embroidering, higher light intensities are necessary, and the eye is grateful for them. Eyes with incurably defective vision and healthy eyes poring over very small or poor print find more light welcome. Many who cannot do with a "normal" amount of light are wearing either improper glasses or none at all when they should wear them.

For the nearsighted person with his wide pupil and for the albino with his lack of eye pigment less light is often more acceptable. Some are allergic to light just as others are to heat, cold, feathers, horsehair, strawberries, and peach-down. For these, lighting becomes a serious problem, requiring the expert advice of the doctor and the illuminating expert. After a long siege of illness strong light is uncomfortable to the eyes and should be cut down. Even in normal eyes light tolerance may vary from day to day. There are many kinds of "normals" and many variations in the same individual at different times, depending on the general physical condition, whether the person is rested or tired, healthy or sick, etc.

By and large, the young eye needs less light than the old eye, the well-seeing eye less than the poor-visioned eye, the healthy eye less than the diseased eye, and the light blue eye of the blond less than the darker eye of the brunette.

What about the *quality* of light? It must be diffuse and glareless for maximum comfort. And it has been found that an adequate quantity of light can give much discomfort if not of the proper quality. Sufficient light, then, does not always mean sufficiently good light. Often the stronger the light the greater the discomfort, because of increased glare. Working in the direct rays of an unprotected electric bulb is an open invitation to eyestrain and fatigue.

Natural daylight is diffused for us by the atmosphere and by the buildings and objects that the sunlight hits before it reaches us. The clear daylighted sky, away from the sun, has no glare. But an unshaded electric light giving only a thousandth part of the light of outdoors can be and often is glary

because we do not take advantage of nature's example when we make our own illumination.

Many reading and study lamps, especially of the gooseneck type, are arranged to throw light on the table, not on the book or working surface. And beautiful desks with bright, shiny surfaces and glass tops reflect the rays of the desk lamp right into the eye. As a result people find themselves pushing away from the frying pan of glare into the dim fire of reduced and insufficient illumination. A dull blotter on the desk surface often helps to diffuse such light. A book or magazine printed on highly glossed paper looks better than it reads, whatever the contents; it will be a source of discomfort unless the proper light is used. In this respect the "pulps" are better, unless the light is good, than their aristocratic cousins the "slick" magazines.

Nor does it matter a great deal whether the light comes over the right or the left shoulder, as long as it is situated where it will throw no shadows on the reading or working area and will not shine into the eyes. Most of us being right-handed, this is often best attained by a light coming from the left and behind. But there is no law — except that the eye be comfortable.

Diffuse, glareless illumination may be obtained in various ways. The most common is by the inverted reflector type of lamp or indirect light unit that throws the light upward. It is then reflected down into the room, duplicating to some extent the light diffused from the daylighted sky. Such light, of course, requires more current — 250 to 300 watts, usually — than direct light, but it is worth it in eye comfort. If the walls and ceilings of a room are dark, much of the light is absorbed, and then even more electric current is necessary.

A frosted or opalescent bulb may absorb up to 30 or 40 per cent of the light, but it is preferable to the clear unshaded bulbs that are occasionally seen. There are many patented types of lamps on the market that give a good diffused light. Some have gratings that break up the straight penetrating light rays. Others disperse the light at the source by means of diffusing substances incorporated into the housing of the

bulb. Some do not do all they promise, but on the whole they are far better than the direct lights found in most homes.

It is better for the eye if the source of illumination is removed from the field of vision. Most of us forget or do not realize that our heads with their overhanging brows and movable upper lids are built to protect us from overhead glare. As a matter of fact most of our looking is in the downward direction or straight ahead; we do very little upward gazing. We deliberately proceed to counteract the protection afforded us by nature by placing lamps below eye level instead of above, where the light would fall on objects from overhead and not shoot into our eyes from below. Shaded lamps on low tables may give a room that certain atmosphere, but they also give an uncertain light. It does the eyes no good.

Another important element in eye comfort is the distribution of light. A room lighted by a few bright islands of illumination in a sea of semi-gloom makes a poor study or workroom. Few of us have the concentration to work or read hour after hour without looking up. Most of us look around every once in a while or are interrupted occasionally. This forces the eye to a continuous and involuntary adaptation from light to darkness and back to light. The pupil does this almost instantaneously, but the retina takes longer. This constant adjustment and readjustment fatigues the eye. A flickering source of light in trolley or train is tiring for the same reason.

We have all experienced the painful sensation in the eyes of emerging from darkness into sudden bright light. The instant adjustment required is more taxing than the more gradual adaptation of the eye from light to darkness. Multiply this a hundred times and you get an idea of what you do to your eyes in lesser degree when you read by a flickering light or in a room with poor light distribution. Indirect lighting, too, may sin in this respect if it is confined to one strongly lighted area while the rest of the room is in darkness. The best type of indirect lighting is that in which most of the ceiling and upper walls are lit up.

Many questions are asked about the "best color" of light for the eyes. As already indicated in Chapter VII, there is no

evidence that any single color is of actual benefit to the eye. It is believed now that the best-tolerated light is the plain white light that most nearly approaches sunlight. Certainly it is better than any kind of colored illumination. Unfortunately, it has been difficult to approximate plain white light for general use until the recent advent of fluorescent lighting.

The so-called "daylight bulb" is less well tolerated than the plain white frosted bulb. Since I have just said that daylight is the best form of illumination, this will seem surprising. The explanation lies in the fact that our retina is more sensitive to the yellow portion of the spectrum than to the blue, and, as we have seen, the plain white bulbs transmit these yellow rays while the bluish "daylight" bulbs absorb them to a large extent. Hence the former are easier on the eye.

Another frequently asked question is whether reading in bed is harmful. The answer is no — if it is done under proper lighting conditions. For many of us it is the only time and place where complete relaxation and concentration are possible. With an adequate light there is no more objection to reading yourself to sleep in bed than in an armchair.

In the past four or five years fluorescent or the "electric discharge" type of lighting has been so improved that it is rapidly finding increased popularity for general use. The neon sign and the sodium street-lamp are earlier examples of this type of illumination. In the ordinary electric lamp, light is obtained by heating a tungsten filament to incandescence by means of an electric current. The more recently perfected fluorescent lamp produces light because of the ability of certain chemical substances to fluoresce and give off light when activated by ultra-violet rays.

Roughly, the process is this: The inside of a long tubelike glass lamp is coated with a fluorescing chemical powder. A drop of mercury is placed inside, and the electrodes are sealed into the closed ends of the tube. When the electric current is turned on it vaporizes the mercury, which gives off ultraviolet radiations. These, in turn, activate the chemical coating of the inside of the lamp, and fluorescent light rays are given off. In some ways this is similar to the "fox fire" previously

discussed; that is, the chemical absorbs energy in the form of invisible ultra-violet rays and gives it off in another form as visible light rays.

Before fluorescent lighting comes into more general use, however, some wrinkles will have to be ironed out. While the cost of its operation is approximately the same as that of incandescent lighting, the expense of installing the necessary equipment is much greater. It works well with alternating current, but not with direct. Then there are such "bugs" as a hum from the light, which may be disturbing, interference with reception if too close to the radio, and diminution of efficiency in extremes of temperature – both hot and cold. None of these is a serious obstacle, and approaches to their correction have already been made.

In one respect fluorescent lighting is too good. Our eyes have been educated to recognize colors indoors under the warm, relatively yellowish incandescent light. The new fluorescent light, being whiter, seems colder to the eye and gives us a different – if more correct – idea of color values, which is sometimes bewildering. But here again the objection will probably be cured by time and experience.

And, finally, there is the possibility that fluorescent lighting may increase our quantitative light requirements. Apparently, the better diffused light is, the more the eye can stand. This may be why daylight, our best diffused light, can be tolerated in much higher intensities than artificial lighting. The same rule holds indoors also; so that the better the light qualitatively, the higher the intensities which can be borne by the eye.

Our indoor lighting standards have until now been based on incandescent light and have been rather low. It may well be that fluorescent light with its far better diffusion will change our whole concept of indoor lighting considerably and raise the standard optimum requirements.

The jump from fire to electric illumination was a prodigious one. The step from incandescent to fluorescent lighting, while not so great, is also of major potential importance. For with the latter, even at this early stage, it is possible to get an

adequate intensity of illumination without glare, and the nearest qualitative approach to sunlight we have so far.

I said at the beginning of this chapter that the human eye works at maximum efficiency under minimal illumination. Many of us get along quite well with much less than the optimum amount of light, apparently with no ill effects. However, this does not mean that we should not be better off with more light. It only proves that the well-corrected normal eye has good vision over a wide range of illumination and can stand for a great deal. We have at our disposal an excellent mechanism of which we often take an unfair advantage.

The common complaints of tearing, burning, itching, blurring, pinkeye, sleepiness, etc., may be due to insufficient light, too much light, or the wrong kind of light. In other words, the eye reacts to insult in somewhat similar fashion no matter what the cause. In the presence of such symptoms the important considerations (excluding actual pathology and muscle imbalances) are (1) proper correction of vision if necessary, (2) the proper amount of light, and (3) the proper kind of light.

In a world where we are adjured to cut down the illumination with tinted lenses because there is too much light and urged to increase the light because we have too little, the average person is often confused and at a loss as to the proper procedure. If there is any doubt, the safest procedure is to seek unbiased and competent advice when necessary.

It is impossible, by and large, to make inflexible rules for a variable, elastic organ such as the eye or for the varying habits and requirements of that hopefully named animal, homo sapiens. Each case must be decided on its own merits.

X

The Eye in Traffic

Seventy per cent of the world's automobiles are crowded into the United States, and thirty-five million Americans guide the destinies of gas-eating vehicles. In 1906 only one out of every 800 citizens dared to brave the gibes of his neighbors and risk his life and temper in the new-fangled motor car. He spent a lot of time imprecating the contraption, looking upward from a supine position on the ground. With a faceful of grime, a bodyful of aches, and a long, bedraggled linen duster, he came home a loser from his Kampf with the dusty, unpaved roads. That year's motor mortalities numbered 0.5 per 100,000 population. In 1940 one out of every four of this country's inhabitants drove a car an average of 9,000 miles, most of it over good hard-surfaced roads. I shall leave it to you to figure the total mileage covered, but I can tell you that the traffic deaths were about 27 per 100,000 population and automobile injuries totaled 1,320,000 in number.

It must not be inferred from this that automobiling in the good old days was entirely safe, if less pleasant. On the contrary, unskilled driving and the almost total absence of traffic laws caused more deaths *per motor car owned* then than now. But the main body of citizenry was safer, because fewer cars cluttered up the roads. Now, with the number of motor vehicles increased over 250 times, traffic deaths have increased fiftyfold. This is what improvement in automobiles, roads, and technical skill have done for us.

The astoundingly rapid increase in motor traffic is a tale that needs no retelling here. In normal times the motor car is not only the luxury, but the commonest necessity, of much of our population. A large share of our national income, large or small, goes into the automobile. Half of the car owners of

this country earn $30.00 a week or less; three-quarters have an income of less than $40.00 a week normally. The American will part with everything he owns before he gives up the family bus. He would rather ride than eat.

This has created a problem in traffic regulation with which we have not yet caught up. It is only within the last ten years or so that most states have begun to make serious efforts to control the American driver.

Up to 1914 only ten states and the District of Columbia required drivers' licenses. Ten more were added in the next fifteen years. Today there are still three states, Louisiana, South Dakota, and Wyoming, that let who will be a driver, if he can get something to drive. In addition to these, six more states, Florida, Montana, Minnesota, Missouri, Nevada, and North Dakota, require a driver's license but make no pretense at any kind of examination. All you need do is lay a fee on the line.

Five more states, Arkansas, Idaho, Mississippi, North Carolina, and Oklahoma, do not include a road test in their examination of all new drivers. And as this is written there are still fifteen states in the Union that require no vision test of all applicants. In many states where vision tests are mandatory they are either given inefficiently or the standards are too low.

Thus, while thirty-nine states and the District of Columbia have some sort of licensing examination, some do not have a road test, others do not require a vision test, and still others do not require a road-sign test. The drivers can be illiterate for all these states care.

Also, in most states now requiring examinations of new drivers all those driving prior to the enactment of the new laws were exempted from examination. As a result 65 per cent of all motor vehicle drivers today have never had any type of driver's test. In other words, while this is being written constituted authority has not the slightest idea as to the visual or mechanical fitness of about 20,000,000 individuals driving cars.

And another thing: Only about half the states have any sort of provision for the re-examination of drivers, and this provision applies only to late renewal of licenses, to those in-

volved in serious accidents, or to drivers who have reached a certain age (as in Massachusetts, Delaware, and New Jersey). It requires no great intellect to arrive at the conclusion that many of those driving cars today — by the sheer weight of averages — must be, or must have become since their last examination, incapacitated either visually or otherwise and should not be allowed on the streets. Yet there seems to be no legal way of weeding them out and stopping them.

That the crux of the automobile accident problem is more rigid control of the driver seems obvious. Drivers' examinations, however dissimilar and heterogeneous, have proved their worth. During the decade from 1926 to 1935 the death rate per driven mile dropped 15 per cent in those states that require drivers' examinations and increased 28 per cent in those requiring none. If a minimum standard examination could be enforced in all states, more of us would come home alive and healthy.

Of course, there are many human qualities for which no standard can be set. Care, judgment, and respect for the other driver defy the human yardstick. Recklessness, speed mania, love of hard liquor, and hidden mental disease are often discovered only when it is too late. But the vision test, the road-sign test, and the driving test — all depending directly on the visual capacity of the prospective driver — are susceptible of definite, unequivocal standard determinations. With our modern methods of eye examination there is nothing to prevent their enforcement — except, perhaps, the desire of each sovereign state, jealous of its autonomy, to regulate its traffic licensing as it sees fit.

And yet, strange as it may seem, some of the arguments against setting hard-and-fast visual standards for auto drivers sound reasonable. For we really are not yet certain as to what these standards should be.

"It is well enough," some argue, "to decide how much a driver *should* be able to see. But how can we decide what he *must* be able to see? Why disbar many careful drivers who have never had an accident just because they cannot measure up to certain arbitrary standards? There are many keen-eyed

drivers who are death on wheels; they just haven't been caught yet."

Memo Number 42 of the National Safety Council puts it succinctly:

> A social balance must be reached in which the safety of the many is weighed against the sacrifice of a few. We do not like to bar people unnecessarily from our roads, yet if they are hazards, we must do so. Of course, the root of the trouble is lack of data.

And the few data we have are conflicting because our standards are. Visual requirements vary in the several states from a minimum of at least 20/30 in both eyes without glasses to 20/70 in one eye with glasses. Some states also require color or field-of-vision tests or both. Some require neither. The field of vision is the area over which the average individual can detect peripheral motion while looking straight ahead. This normally measures 90 degrees outward and 70 degrees downward, but only 60 and 50 degrees nasally and upward respectively, because the nose and the forehead get in the way. It will be noted that the field is greatest where it is most useful – i.e., to the outside – and narrowest upward, where we need it least.

In an effort to standardize all conflicting requirements the American Medical Association appointed a special committee that made the following visual recommendations:

1. *Visual acuity with or without glasses of 20/40 in one eye and 20/100 in the other.*
2. *A form field of not less than 45 degrees to both sides laterally from dead center ahead.*
3. *Binocular single vision (i.e., the ability to use the two eyes together normally).*
4. *Ability to distinguish red, green, and yellow.*
5. *Glasses, when required, to be worn while driving.*

A somewhat lower set of standards was prescribed for "limited" licenses.

The American Association of Motor Vehicle Administrators, with the co-operation of Yale University's Institute of Human Relations, also issued, in August 1939, its Minimum

Driver License Examination Standards. In substance these require that:

1. *Every applicant should be able to read and understand highway signs regulating traffic.*
2. *He should have a minimum vision of 20/60 in* one or both *eyes. If glasses are necessary to attain this vision, the license must specifically state so.*
3. *Every applicant must have a reasonable understanding of the traffic laws of his state.*
4. *The applicant must demonstrate his ability to exercise ordinary and reasonable control of his vehicle.*

A comparison of these two codes brings out some startling differences in visual requirements. They may be summed up as the difference between the scientific and the practical approach to the problem of regulating traffic. The latter code contains nothing about the form field, nothing about single binocular vision, and nary a word about color vision. Why?

Every traffic expert knows that there is a good deal more to vision than the ability to read a certain size of letter at a certain distance. He knows that normal visual capacity (which means a great deal more than normal visual acuity) includes also a good field of vision, binocular single vision, color vision, the ability to accommodate normally – i.e., to look far away and then in turn near without trouble – and also to see well in the light and in the dark.

Every traffic expert knows that it is the normal field of vision that helps the driver to see from the corner of his eye such cars and people as pass him while he is looking straight ahead. He knows that it is single binocular vision that helps us to gauge just how far another car is ahead of us, whether it is going faster or slower than we are, and whether there is enough space between two cars to squeeze through. And then there is the color requirement. How is the driver to know when to go and when to stop if he is color blind?

After all, the Advisory Driver Research Committee of the A.A.M.V.A. included the Motor Vehicle Commissioners of New York, New Jersey, Connecticut, and Vermont as well as

the Director of the Institute of Human Relations of Yale University and other experts. Why did they limit the visual requirements to a bare ability to read English and see 20/60 — with glasses if necessary? It was not from lack of knowledge, but as a result of years of experience, that more stringent visual requirements were not made.

For instance, there seems to be no proof that the one-eyed individual, whom all states permit to drive, is involved in traffic accidents any more than his two-eyed brother. On the contrary, knowing his deficiency in both binocular vision and field of vision (though he may not call it that), he is usually a more careful driver than the more visually blessed one. This is corroborated by officials of several state motor vehicle bureaus.

Then there is the color-vision requirement. Everyone knows that the predominant type of color blindness is the inability to distinguish red and green. And since traffic signals are exactly these colors, all red-green-blind individuals would appear, ipso facto, to be a definite hazard to other cars and pedestrians. Not to require this test, therefore, seems even more inexplicable.

A letter received by the author from Mr. J. S. Baker of the Public Safety Division of the National Safety Council contains the following significant paragraph:

> There does not seem to be much real hazard from color blindness. Since traffic signals are widely used, and since red tail lights are standard, it would seem that persons unable to perceive red or green would be a hazard. This neat bit of logic, however, is not substantiated by the accident statistics. For the last ten years, I have been looking for a single good case to represent a driver who had an accident which he would not have had, had he been able fully to distinguish colors. Such an accident has not come to my attention. A number of them have been reported in medical periodicals, but in tracing them down they usually turn out to be hypothetical rather than actual cases. I do not have any doubt that such accidents occur, but they are extremely few and accidents due to inability to see in low degrees of illumination, for example, are much more common although less talked about because the faculties involved are less understood by the public.

And here is another fact: In a study of color blindness recently made, 1.3 per cent of over 700 traffic violators studied were found to be partially color blind, 5 per cent were totally red-green blind, and one individual could distinguish no colors at all. And yet all but three were able to call the red and green signal lights easily. These three were mentally diseased.

None of the men studied had records of serious traffic violations, and the percentage of those getting tickets for passing a red light was much smaller than among those with normal color vision haled into court for the same offense. An interesting observation was that, while many of these confused the colors of their suits and ties, they had no difficulty with the lights. Instances where proved red-green-blind men had driven hundreds of thousands of miles without accident and had even received awards as safe drivers were also reported.

What then is the explanation for this truly remarkable phenomenon? In order to get the complete answer we must go a little afield. And I can already hear curious readers asking: "Why use red and green traffic signals at all when these are the very colors to which approximately 5 per cent of all males are particularly vulnerable? Why look for trouble?"

Of course, from time immemorial — from long before we had our present knowledge of colors — red has been the signal of danger and is therefore psychologically the ideal stop signal. Since green is the complementary color, and therefore the most distinctive opposite, it is the natural color to indicate the reverse of stop.

But the adoption of these colors for traffic purposes was not quite so theoretical a development as all that. It was due also to good practical reasons. Of the commercial glass available for signal lights up to now, the blue gives only two per cent luminosity, and in foggy weather practically nothing. Furthermore, blue is less desirable as a signal light, because it looks hazy as compared with the clear-cut brightness of the red light. Purple is also bad, because in the glass available it is very likely to be confused with red, and it also has poor luminosity. Yellow and orange, though bright enough, are too easily confused with white under adverse weather conditions,

such as fog. In a series of experiments performed by the National Bureau of Standards at the request of the Bureau of Aeronautics of the U. S. Navy Department it was determined that "orange and yellow . . . are the least distinctive of all the signal colors." That leaves only red and green, which, in the glass available, transmit from 10 to 20 per cent of all the light and are hence *practically* the best colors to use.

And now, why are there so few accidents due to color blindness? There are several explanations. When in 1918 traffic lights first startled both drivers and pedestrians on Fifth Avenue in New York City, red, green, and white were used. The same color was visible at the same time in all four directions. One color meant for traffic to proceed north and south and for east-west traffic to stop; another allowed only east-west traffic to move. And when white appeared in all four directions simultaneously it meant that all traffic was to stop and wait for the change.

It did not take long for authorities to realize how cumbersome and inefficient this system was. Constant improvement finally gave us our present efficient regulations of red in one direction while green shows in the other. In many localities yellow has been eliminated as unnecessary.

Now your red-green-blind individual has learned from long experience to distinguish the red from the green signal by their varying *brightness,* although he does not see the colors as such. That is, he takes advantage of the fact that all colors vary in brilliance under the same conditions of illumination as previously described; and although he may see them both as fields of gray, the gray given by one light will be brighter, and he has taught himself unconsciously to differentiate them.

Secondly, in most large cities and towns the standard regulations now require that the red light be above the green. With this knowledge even a color-blind driver can tell which light is on and which off.

In some South American cities, Barranquilla, for example, the traffic signals at some intersections consist of a stationary light around which revolves a glass globe painted half red

and half green. In one case I had to instruct a red-green-blind driver when to go and when to stop; he was completely befuddled. Not only did he have no positional clue, but the signal consisted of a poorly colored glass in which the distinction of brightness was difficult to make out. This illustrates the advantage of our on-and-off signals, at least to the color blind.

In the third place, the standard green traffic signal is really a bluish green (admiralty green), and it looks a weak blue to many color-blind individuals and is hence distinguishable from the upper signal light. In the case cited above the color was a nondescript green.

Fourthly, and probably most important, especially in heavy traffic where accidents are most likely to occur, the careful driver simply "follows the traffic." He watches the other fellow and acts accordingly.

Color-blind drivers also have many ingenious tricks to help them. One is to stick a red or green celluloid filter on the windshield. This lets through either the red or the green light only, and in this way it may be seen which light is on and which off. There are also tinted glasses on the market in which the lenses are half green and half red. By watching carefully the driver is enabled to tell which light is on and which off. In the main, however, such contraptions are unnecessary.

A color-blind person should never wear deep brown or amber glasses. These absorb both the red and the green rays and are hence dangerous. Incidentally, this also goes for all drivers.

Tinted lenses of the right color — the wrong color in this case — can make it difficult to differentiate any kind of traffic signal. Out on the open road they may not make much difference, but in towns and cities, where traffic is heavy and signals are numerous, they become a source of danger. This is especially true when the driver is not color blind and therefore not on his guard. A very dark green sunglass will blot out the red signal light, and a very dark red one will blot out the green. Both these colors, as well as the deep amber, should be avoided by all drivers.

It would appear, then, that the problem of the relation of color blindness to modern traffic and industry, while important, can be overestimated. In all our transportation and industrial systems, as well as in our naval and aviation forces, the color blind are weeded out by rigid examinations. The army will take color-blind soldiers, but all officers must have normal color vision. In ordinary traffic, even in those states where no examinations are required, few accidents due to color blindness occur, as we have seen. All of us have friends whom we have chaffed about their inability to tell red from green. How many do you know that have received tickets for passing a red light?

The standards set by the American Medical Association would undoubtedly give us drivers with better visual ability. But, judging from all available records, they would ban many safe, careful drivers who do not deserve to be barred from the roads despite their poorer visual efficiency. And this explains the more liberal visual requirements of the A.A.M.V.A.

It may well be, however, that these two points of view are by no means antithetical. It is, in fact, highly probable that when driving laws become more standardized and all the evidence is in, the necessity for increased visual requirements will become more apparent. The recently revised regulations of the Interstate Commerce Commission already show which way the wind is blowing. These require that drivers in interstate commerce have a corrected vision of at least 20/40 in one eye and 20/100 in the other, a form field of at least 45 degrees in all directions, and the ability to recognize red, green, and yellow.

There is additional evidence of a deeper appreciation of the fact that mechanical defects are responsible for only 10 per cent of motor accidents, and that the other 90 per cent are due entirely to the human element. In New York every applicant for a driver's license has recently been required to take a *written* examination on road rules. At least this will assure a hitherto unrequired ability to read and write. In New Jersey a campaign is afoot to require all aged drivers to undergo a periodic health check-up to determine their fitness to drive a

car. And this same state now refuses drivers' licenses to those few applicants who show complete inability to distinguish between red and green traffic lights. A few other states, including New York, require a color test, though no applicant is disqualified for color blindness. All such data will help us to decide many hitherto unanswered questions.

These few pages cannot possibly offer a complete discussion of the whole problem. Many of its technical details concern only the traffic expert and the eye physician. Furthermore, the tempo of our lives, the complexities of our civilization, and the ever increasing number of cars and drivers are posing so many new problems for us that we cannot hope to keep up with them here.

To give you one little example: Every automobile driver is bedeviled and confused by the colored advertising signs that decorate our main city thoroughfares. Very often the red and green traffic lights are lost in this sea of colorful lighting. It is a traffic hazard. But how dissolve it? Regulate the color and position of street signs? What colors shall be permitted, and where? Decree distinctive shapes for traffic signals? What shall they be? And this is only one minor problem.

And then there are the psychological aspects of the traffic problem, which have not received their meed of recognition here. We simply do not know enough about them. What is an absolute test for such psychologically important factors as carefulness, courtesy, judgment, ability to act quickly in the clinches, and so on? We do know that these attributes have never been the sole property of the human being with superior vision.

All we can do here now is to point out that, according to the evidence, given a code substantially similar to the one above, uniformly adopted and administered by all the states, traffic accidents would decrease. This is just as sure as that the number of cars and accidents is now increasing.

Regulation of night traffic has all the difficulties inherent in the daylight traffic problem plus a few complicating elements of its own. Curiously enough, it is concerned with too much

light as much as with not enough. It is a more serious problem in many ways.

In earlier days there was relatively little night traffic. Old Dobbin seldom had to be routed out after sundown. He might even have been counted on to pick his way carefully along the dim road if Grandpa was drowsy. Not so the iron Dobbin. If you give him his head, you can count on only one thing: catastrophe. You can count on it anyway.

Figures published by the National Safety Council show that 61 per cent of all fatal motor accidents occur at night, though only one-third of all the driving is done between sundown and sunrise. Not only that, but since 1930 night motor fatalities have increased by 43 per cent, while we have been able to reduce daylight motor deaths by 5 per cent. The automobile does not shy away from trouble; it seems to seek it.

The reasons for this coincidence between night traffic on our highways and across the River Styx are many. First and foremost is the tremendous increase in driving by night as well as by day. From the scarcely discernible horse-drawn trickle of forty years ago it has grown to a steady motorized flood through all the highways and byways of our country.

But in order to keep the record straight and for the benefit of the nostalgic mourner for the good old departed days, I must hasten to add that *per driven mile* the horse and buggy had no greater respect for human life and limb than the mechanical buggy. This seems proved beyond a doubt. The point is that today we are a nation with a lust for motor travel. They were less peripatetic in earlier days.

Other important causes of accidents at night are excess speed, fatigue, poor directional signs, drunkenness (almost 80 per cent of all accidents due to drinking occur between 6 p.m. and 6 a.m.), poor illumination, and night blindness. Most of these factors are well understood. But we know little about the last-named.

We do know that lighting and traffic engineering have failed to keep up with the marked improvement in the speed and efficiency of the motor vehicle. The man at the wheel of the modern car must control, on the average, the power of

ninety horses as compared with the eighteen-horsepower motor of thirty years ago. And this is ninety times the power, speed, and capacity for destruction that the horse and buggy driver had at his disposal. Figures show that — here as in other instances — our ability to use our inventions has not kept pace with our capacity to create them.

Night traffic accidents are directly related to illumination, and improved road lighting always gives a reduction in accidents. In 1938 New Jersey had 37 per cent fewer night accidents than in 1937, as a result of better road lighting.

Beyond the confines of the city, night driving depends to a large extent for illumination on our own headlights. Modern automobiles provide adequate lighting equipment for travel at night at a reasonable speed, if the car is well cared for. This means that lamps must be kept in good condition, the bulbs clean, the reflectors bright, and the lights focused properly. Neglected headlamps are a source of danger. But an even greater source of danger is not your own headlamps, but the other fellow's. You know how often he neglects to dim them when approaching you. (I hope you don't forget to dim your own.)

The powerful headlights of an approaching car are troublesome for several reasons. First, we know that the eye is much more sensitive in the dark; the pupil is much more widely dilated and the retina more responsive than in daylight. Secondly, the contrast between a bright source of light and the surrounding gloom is greater than it would be between the same headlight and daylight.

The most powerful searchlight is barely visible in the light of day, but at night a lighted match or candle can be seen about ten miles away. (And we know of at least one Allied steamer sunk by enemy submarines because a lighted cigarette end was carelessly exposed and spotted miles away at sea.) But the most important reason why headlights cause trouble is that many of them throw a sharp, glaring light and not a diffuse one. This is dangerous not only because such a beam blinds us immediately, but also because of its aftereffect on our vision.

The rôle of the visual purple in night vision has already been mentioned (Chapter II). The story of its discovery is an interesting one. In 1861 a man named Muller found a remarkable substance in the retinal rods of frogs that had been kept in the dark. It was called rhodopsin or visual purple. About twenty-five years later experimenters discovered that this material disappeared when exposed to light. It was subsequently discovered that it mysteriously reappeared when the light was removed. In many ways its action was not unlike the photo-chemical reaction that makes all photography and the candid-camera fiend possible: that is, the action of light that produces an image on the silver compound of a film. But the eye goes the camera one better by reloading automatically and continuously. Once the picture is taken and registered in the brain, the eye instantaneously erases it, and the retina is ready for the next visual impression.

Incidentally, this bleaching out of visual purple by light has been gleefully adopted by our story-tellers in rather ingenious ways. Occasionally one sees a movie or reads a mystery tale in which the plot depends on the discovery of the killer's likeness etched on the retina of the victim. Now, the factors that make the outlines of a bright object visible on the human retina are somewhat as follows: First, the pupil has to be widely dilated. Secondly, the eye has to be exposed at close range to an exceedingly bright light source for at least a minute and a half. Then the retina must be dissected out under a yellow sodium light and fixed in a four-per-cent alum solution. Then, on examination, the *outlines* of a "picture" — no details — may be seen. But no countenance, however incandescent, is sufficiently bright to be photographed there. The detective who could spot the killer's image by one peek into a dead man's eyes never existed, because the image never did.

To get back to the subject: As night falls the eye normally adapts itself slowly from light to darkness by accumulating visual purple and stepping up its sensitivity. It has been found that it takes the eye from half an hour to an hour to become completely dark-adapted, though for the ordinary require-

ments of daily life we need only a few minutes to adapt ourselves to lesser changes in light intensity.

This phenomenon has been experienced by everybody on entering a dark movie house from a brightly illuminated lobby. At first everything is pitch dark. Gradually people and objects emerge from the general obscurity and take shape — not because there has been any increase in the light, but because the eyes have adjusted themselves to their new environment by "turning on the juice." The reverse process, adaptation to light from darkness, is much more rapid; but it also requires an appreciable length of time.

Now, given a sudden powerful light from a headlamp flashing into the eye, the visual purple is bleached out so rapidly and completely that the vision is strongly disturbed for some time afterward. During the interval of recovery, before the retina has had a chance to readjust itself to darkness, many unpleasant things can happen and often do. On a well-traveled road with an opposing stream of traffic constantly glaring into your eyes, the effect is obvious. That is why night driving is so tiring to the eyes, besides being dangerous to life and limb.

Recent battle experiences have also taught us that light at night in the wrong place can be a bitter and deadly enemy unless proper precautions are taken. In olden times the waging of war was a daylight proposition. Armies fought from sunrise to sunset and then withdrew to bind up their wounds and prepare for the next day's fighting. Modern warfare is not only total, but constant. It goes on twenty-four hours a day, and fighting men, for their own protection and the confusion of the enemy, must be taught the proper use of dark-adaptation. This knowledge has often meant the difference between death and survival.

Soon after the advent of the match, sailors on night watch learned empirically to close their eyes when lighting their pipes. Now, on a basis of scientific knowledge, gunners are cautioned against watching the flashes of their guns in night fighting. We teach soldiers and sailors about to go on night watch to remain in a darkened room wherever possible for at

least fifteen minutes in order to sharpen their night vision. A little trick frequently employed when exposure to light is unavoidable is to close one eye or to cover it with a patch. These are makeshifts, but better than nothing when night adaptation is important in an emergency. Our old friend the red light is also used for illumination wherever possible to minimize the loss of dark-adaptation.

In the regulation of night traffic — to get back to our particular problem — the situation may be further complicated if the driver lacks a sufficiency of visual purple; if, in other words, he is suffering from night blindness. The question as to how prevalent night blindness is and what part it plays in night traffic accidents has not been definitely answered yet. It is a new subject, and the evidence is conflicting. Fortunately, we know a good deal more about the causes of night blindness than we do about those of color blindness. The latter involves an *unknown* disturbance of the retinal cones, the former a *known* disturbance in the retinal rods.

We know, for instance, that certain degenerative conditions of the retina itself, general toxic disturbances of the whole body such as acute alcoholism, diseases of the liver, and many other illnesses are well established causative factors of night blindness, because they affect the peripheral or night-seeing portion of our retinæ. Like color blindness, night blindness may even be inherited. But all such cases are relatively rare. The most common cause is probably vitamin A deficiency.

Of course, just as two pairs of normal eyes may vary in visual ability by day so may they vary in the dark — and still be normal. Some individuals just seem to have the inherent faculty of seeing much farther at night than others. But it has been established that unusually poor vision at night in an apparently healthy eye may be due to the partial absence of visual purple from the retinal rods. And visual purple, in turn, has been found to be dependent largely on the supply of vitamin A in the body. The process, as nearly as physiological chemists have been able to give it to us, works something like this:

Vitamin A is picked out of the blood stream by the retina

and as visual white is combined with other protein substances to form visual purple. On exposure to light it is bleached to visual yellow. The latter, in turn, is converted back to form visual white (vitamin A compound). And so on indefinitely, if the supply of vitamin A is adequate. For during this process a certain amount of vitamin A is used up, and a constant source has to be supplied for replenishment. Not all the steps in the process by which vitamin A is extracted from ingested food and loosened into the blood stream are known. But it is this colorful transformation from visual white to purple to yellow and back again that gives us our ability to see under conditions of very poor illumination.

It would seem that, knowing so much, we might easily determine how prevalent night blindness due to vitamin A deficiency really is and what part it plays in night traffic accidents. It is by no means easy, for the subject is a new one, and the evidence is conflicting. Some proof has been adduced to show that there is a more generalized vitamin A insufficiency — even among the well-fed portions of our population — than was formerly supposed. On the other hand, there are reliable investigators who have shown no such thing. Unfortunately our methods of investigation have not yet been refined down to the point where all the results can be accepted as incontrovertible.

Vitamin A occurs in fats such as butter, cream, and milk; none of these is a popular food among the reducing-diet portions of our population. It also occurs richly in such vegetables as spinach, carrots, and chard — not to be characterized as popular appetizers. But it is also found in beef, mutton, and egg yolk, and to a lesser extent in apricots, green beans and peas, Brussels sprouts, lettuce, tomatoes, squash, pumpkins, and sweet potatoes as a yellow pigment called carotene. Thus, anyone who eats any kind of varied diet would seem to be assured of an adequate supply, because not much is required.

There may be some who, by reason of an unbalanced diet, are not taking in a sufficiency of vitamin A for maximum general efficiency, including the eye. It has been shown that fail-

ure to ingest adequate amounts of vitamin A may cause eye fatigue and blurring of vision. On the other hand, in a group of over eighty people who had these symptoms, and who were helped by vitamin A, only a few complained of poor vision at night. We have much to learn.

Some investigators have reported series after series of cases showing that a large — a terrifyingly large — percentage of all people examined are suffering from lack of vitamin A and consequently from impaired dark-adaptation. On the other hand, others, using different techniques and standards, scoff at these findings. Thus, in one interesting series of examinations it was shown that vitamin A deficiency has no marked effect on the ability of drivers to recover from glare. Nor was it shown that glare sensitivity increases with age, as is believed by some. What did stand out strikingly was that Negroes, with their darker-colored eyes, are much less sensitive to glare than whites. To a lesser extent this is also true of dark-complexioned whites as compared with blonds.

Also, studies of two groups, one with an adequate vitamin A intake and the other with an insufficient vitamin diet, showed that the average glare sensitivity — i.e., ability to see in concentrated strong light — was approximately the same in both groups.

From these tests, then, it would appear that vitamin A insufficiency may not be *the* determining factor in night traffic accidents, and that the amount of color pigment in the eye — i.e., whether the eye is light- or dark-colored — may be of greater importance than has been hitherto suspected. It would be interesting if a study were made to determine the proportion of blonds and brunets — male and female — in night accidents.

It will be a long time before all our highways are adequately lighted, and until then the problem of night traffic control is right in our laps. If we are to approach it intelligently, we shall have to learn a good deal more about night blindness than we now know. This means much more scientifically controlled investigation. This may also mean that ultimately a test for night blindness and dark-adaptation will

be included in all our drivers' license examinations. Aviation, with its accent on night flying and bombing, required such a test long ago.

As matters now stand there is no conclusive proof that there is a general deficiency of vitamin A among the drivers who control our thirty-two million motor vehicles, nor does it seem likely. Nor is there any scientific evidence to prove that the ingestion of large quantities of proprietary capsules, pills, and oils containing vitamin A will make you see in the dark as the proverbial cat is supposed to (but doesn't). The impression that if you choke down enough of X–Y–Z's product your eyes will practically pop out of your head, so "energized" will they become with "bottled sunlight," is more than a little misleading.

Statistics show that one of every twenty-five motor vehicles in this country gets into some kind of accident every year. Excess speed and reckless driving are factors in almost 85 per cent of all accidents. In the present stage of our knowledge it does not seem reasonable to blame any appreciable proportion of the 35,000 resultant deaths annually on the absence of poor old vitamin A from the diet. Millions of units of vitamin A will not cure the speed maniac or the drunkard, day or night.

But all experts are unanimously agreed on one thing: No colored glasses of any type should be worn at night. Glare is annoying and dangerous without a doubt. But tinted lenses sufficiently dark to cut out this glare would reduce night visibility to such an extent that the probability of night accidents would be much greater with than without them.

An effort to solve this problem has been made from another direction. Quite a bit of experimentation has been done with the polarization principle to obviate glare. Not to go into too many technical details, the idea is to supply all headlights with a special glass so that the emitted light is polarized. This means that only half the light, or that vibrating in one plane, gets through, the other half being absorbed. All windshields would also be made of polarizing material so fixed that the remaining light from the approaching headlight

would be almost completely absorbed by your windshield. With such a uniform treatment of all headlights and windshields the lights of all cars coming toward you would show merely a dull glow, enough to be seen but not to interfere. In similar manner your lights would not bother the other fellow.

The catch here is that with the light from your own headlamps cut in half, wattage would have to be stepped up at least three times to give you sufficient illumination for night driving. Also, a not unimportant item, the present cost of polarizing glass is far above that of ordinary glass. A partial answer to the expense might be the wearing of colorless polarizing lenses by all night drivers instead of making all windshields of polarizing material. The result would be the same, and the cost much less. This suggestion is offered gratis for what it is worth. The whole thing is still in the experimental stage, but it will certainly bear watching. So far it seems to offer the best practical solution yet proposed – except, perhaps, not to drive at night at all. For, despite the confidence of your best friends in such methods of avoiding glare as "looking with only one eye" and "keeping your eyes down on the road," etc., these methods are not very effective. And until some reliable system is evolved we shall go on joy-riding at night, leaving death and destruction in our wake.

There is no intention here to minify the rôle of the pedestrian in traffic accidents. That he is often much more than an innocent victim is readily agreed. Statistics for 1940 show that over 25 per cent of automobile accidents were the result of collision with pedestrians. These could not all have been the fault of the driver. The pedestrian often shows a disregard for ordinary caution and a lack of respect for his own life and limb that passeth mortal understanding. To save half a minute – which is usually of not the slightest value to him – he will go hedge-hopping against the traffic current, bringing out the least desirable vocal sentiments in drivers and swelling the volume of automobile accidents.

But that is not our problem here. We have to do with vision and the visual capacities and requirements of the rider of the

modern iron Pegasus. In the last analysis it is he who controls the destinies of our lives in traffic.

Modern science has succeeded in doubling our life span. But many of us, because of carelessness or inadequacy, permit this increase to be neutralized by still another of our scientific achievements. The development of the automobile has jazzed up our lives and speeded up our deaths. Have we created a monster that we cannot control?

XI

Eye Physicians and Optometrists

In previous chapters I have pointed out the importance of eyeglasses to visual health, comfort, and efficiency. It should be obvious that a large majority of us, the ultimate if often unwilling beneficiaries, have a direct personal interest in the methods of obtaining glasses and in the professions prescribing them. Actually, this interest has always been more potential than real. It is hardly an exaggeration to say that three-fourths of all patients do not know the difference between an eye physician and an optometrist or between their capacities and functions.

For instance, how many reading these pages know that an *oculist* (also *eye physician* or *ophthalmologist*) is a graduate in medicine who specializes in the treatment of diseases of the eye and the correction of vision with glasses? How many know that an *optometrist* is one who only measures the range of vision and prescribes and sells glasses? And how many know that an *optician* does not prescribe glasses at all, but only makes them? These terms are constantly being misused, and by many who should know better.

The confusion is probably due in part to the prevalent distaste for eyeglasses and anything connected with them. A second reason is the failure of responsible agencies to disseminate the proper kind of information. Gestures made in this direction have been practically nullified by the traditional conservatism of medicine on the one hand and the frequently obvious lack of conservative background on the part of optometry.

A third reason is that the two professions prescribing

glasses have themselves been unable to define clearly their own spheres of influence and have to date failed to arrive at an amicable *modus vivendi.* For years the controversy between eye physician and optometrist has been simmering and frothing merrily without bringing joy to either side. Yet it has never boiled over sufficiently to attract much attention from the general public, whom it concerns most.

Hence the nonchalance with which most of us go about getting a pair of glasses. True, some patients who feel that their eyes need attention go directly or are referred by their family doctor to the eye physician. But these make up fewer than a third of all eyeglass wearers.

Most people buy glasses the way they buy a pair of shoes. They go into the nearest store, are measured for size, pick out a pair they like, and then pay for the shoes or the glasses. Let me hasten to say right here that there is nothing wrong with such a transaction, provided the purchaser knows what he is buying, or rather what he is not buying. Frequently he does not know.

From the medical point of view, making the purchase of a pair of glasses the same sort of careless commercial transaction as the buying of a piece of wearing apparel is not the ideal way of treating your eyes. And, if you stop to think about it, you will see that there is very little similarity. For, unlike clothing for the normally healthy body, glasses are bought because something is wrong with us. We feel the need of help for something gone awry.

Frequently what is first noticed is an inability to see clearly. Just as often it is headache or eyestrain or a feeling of heaviness or sleepiness, which we rightly or wrongly attribute to the eyes, and which drives us to seek visual assistance. What most of us do not realize is that the fitting of glasses for vision is only part of a complete eye examination. Frequently it is the least important part. It corresponds to checking the gas, oil, and water in your automobile and completely ignoring the ignition, lubricating, and transmission systems. Every car owner knows what the ultimate result of that would be. Many of the 130,000,000 eye owners in this country are not so wise.

A thorough eye examination implies a check-up of the various external and internal tissues that go to make up the eye, as well as of the external muscles of the eye. Sometimes more detailed studies of the visual fields, color vision, and other ocular functions are required. Such an examination must include a search for intrinsic eye diseases, notably the justly infamous glaucoma, cataract, diseases of the retina and of the optic nerve, and many others to be discussed later. Many of these are not only deceptively insidious, but are treacherously painless. There is always the possibility that unless the man doing the examination is trained to know and recognize these things he may overlook them.

Even more important, the eye often gives us the first clue to serious trouble elsewhere. It is not an isolated organ floating in space, but a part of the whole bodily economy. Its well-being ebbs and flows with that of the rest of the body, and it is affected in one way or another by most of our general bodily ailments.

Inspection of the interior of the eye, where the nerves and blood vessels are easily available for examination — and this is the only place in the body where they can thus be seen in their active, living state — may disclose hitherto unsuspected signs of such conditions as arteriosclerosis, brain tumor, diabetes, syphilis, high blood pressure, kidney disease, tuberculosis, and so on. The ability to see and recognize these things, especially in the early stages when it will do the most good, requires long training and experience with general human disease.

Only after all these investigations have been made should glasses be prescribed. Prescribing glasses for poor vision or headache or eyestrain is treating a symptom, not a cause, until all possibilities other than refractive error have been ruled out. For, while it is true that refractive error is the most frequent cause of such symptoms, they may also be due to any one of the above-enumerated diseases and to hundreds of others. In short, the difference between an examination by an eye physician and a non-medical refractionist is that the for-

mer is a complete medical examination of the eyes, whereas the latter is only a check-up of vision.

Patients with real or fancied aches and pains elsewhere in the body will usually consult a physician. But trouble with the eyes seems to be something else again. I am speaking not only of the hanky-panky private patient, but also of the clinic patient who has little or nothing to pay. The attitude does not seem to be a matter of finances. I believe it is due in large part to misinformation and no information.

There is the headache, for example. The value of eyeglasses for the relief of headache has become so well known to the general public that the nearest optometric establishment is the first port of call after several bottles of aspirin have proved ineffective. And one headache will beget you one pair of glasses almost inevitably. Again let me say that there is nothing wrong with this if the headache is of visual origin and is permanently relieved. Often it is; but it may not be.

Headache is the most commonly misunderstood of our common ailments. With the help of advertising many of us have come to believe that headache *means* eyestrain and that improvement of vision is the inevitable cure. Of course, some headaches are due to eyestrain. But not every pain-in-the-head is of ocular origin, any more than every pain-in-the-neck is between head and shoulders. There are numerous non-ocular diseases in which headache is an important, and frequently the only, symptom. For example, sinusitis, migraine, high blood pressure, brain lesions, neuroses, digestive disturbances, and endocrine diseases are but a few. The curative effect of a pair of glasses on all these is exactly nil.

In addition there are many pathological conditions of the eye itself that produce headache, and that require specific medical treatment for which eyeglasses are of no earthly use. These are all medical problems and must be treated as such. In our zeal to improve vision we often forget the eye and its ills along with the rest of the body.

Misinformation about "drops" is another influence in keeping people from a proper medical eye examination. Fright-

ened by the horrendous stories of their dire effects, some people will shrink with horror at the mere suggestion of these supposedly malevolent and mysterious medicines used by the eye physician to dilate the pupils during an eye examination. The objector has rarely had them himself, but he always knows of a friend or a friend's friend whose light was permanently darkened, or at least dimmed, by drops. These fears are groundless. Thousands of examinations with drops are done in this country daily with no worse results than glasses properly fitted.

Drops are not necessary in all cases. They need not be used in every eyeglass examination of patients over forty-five unless required for some other reason than refractive error. In childen and younger adults, however, the eyes often become so accustomed to straining in order to see clearly that they continue to do so even when they should relax. Here, and also in mental defectives, drops still the action of the eye and enable the physician to gauge the refractive error without the assistance of the patient. Thus drops are used to bring out the full visual deficiency so that the proper correction may be more easily prescribed.

An additional advantage is that a better examination of the inside of the eye is possible with the pupil dilated than with the normally contracted pupil. Drops are frequently used for this purpose alone, and they help in the diagnosis of disease in both young and old. Their effect in clouding vision is always temporary, and no ill effects follow their routine use. A newer type of drop now in use has considerably cut down the duration of the blurring. A patient may now have his eyes dilated in the morning and have clear vision by late afternoon; or, if examined in the evening, he may have clear vision the following morning. Drops are a valuable and often irreplaceable weapon in the physician's armamentarium against the infirmities of the eye.

I spoke earlier of the controversy between physicians and optometrists. There are men who feel that this is a private fight, an interprofessional disagreement that is no business of the patient. I do not hold with this view. A problem that af-

fects the health and comfort of two-thirds of us – as this one does – is of immediate concern to everyone. Every layman is right in the middle of it, and it is his eyes and his health that are under consideration. The more he knows the better he will be able to care for his eyes intelligently.

Granted that this is no place for technical and controversial details, I think that the average man should know what some of the main bones of contention are, in so far as they concern him. The "drops" that I have just discussed are one of these.

Some optometric groups issue literature against the use of drops, insisting that they are "unnecessary" and "harmful." The fact that optometrists are not permitted by law to use them may have something to do with this attitude. Physicians object to it and point out that it is not only unjustified, but also detrimental, because it frightens people and prevents them from getting necessary medication, not only for eyeglass examinations, but also in other cases of eye disease where treatment with various kinds of medicinal eye drops is imperative.

Another disputed point is the well-advertised optometric claim of ability to correct vision better than the eye physician. Not only is this resented by the latter as untrue, but it is fully disproved wherever it has been possible to get figures on the subject. Thus in 1934 a study was made in England, where the situation is similar to ours. It showed that in over 10,000 cases prescribed for by the English equivalent of our optometrists, only 64 per cent needed glasses, and 29 per cent had other optical difficulties that were not recognized.

More recently, in one of the most clearly scientific and dispassionate studies of the subject ever made, over 1,400 American university students wearing glasses were examined. The results proved that over five times as many students still had ocular troubles after being examined by optometrists as after being examined by eye physicians. Also, the average cost of the examination *plus* the glasses was only 10 per cent higher for those examined by physicians. The investigator could not but conclude that optometrists do not serve the public as well as eye physicians. Incidentally, most of the college students

did not know the difference between an eye physician and an optometrist.

From the public's point of view, however, the most serious criticism of optometry is that for lack of medical training it cannot possibly do what it professes to do and asserts it can do — examine eyes. This is evident from a long experience of physicians with former optometric patients. The fact that most of us, luckily, have healthy eyes is no protection to those that have not. A recent incident in Alabama is illustrative.

A woman, complaining of pain in the eyes, was fitted with glasses by an optometrist and assured that they would relieve her pain. After she had returned several times with the complaint that her eyes felt no better it was discovered that the vision of her right eye was completely gone. An eye physician subsequently found that the patient was suffering from glaucoma of both eyes; and she finally lost the right eye. She brought suit against the optometrist; but according to the presiding judge the duty resting on the optometrist as far as the eye was concerned was "only measuring the functional powers and adapting mechanical means for the aid thereof." The optometrist, said the court, was not required or even authorized to diagnose or treat diseases of the eye. The disease of this woman's eyes was not such as should have been detected by a skillful optometrist, and he was therefore not negligent in failing to detect it.

Nor is this an isolated legal ruling. In a recent decision in Washington, D. C., it was held that optometry is an exception among professions because it lacks the doctor-patient relationship. The legal distinction was drawn that the law "neither requires nor contemplates that an optometrist shall be a physician, or that he shall diagnose or treat diseases of the eye."

These cases bring out several important facts. First, an optometric examination is not a medical eye examination: it is merely a check-up of vision. Secondly, the optometrist is licensed only to fit glasses for vision, and the law does not require that he know anything about diseases of the eye; in fact, it states definitely that he is not responsible for such

knowledge. Thirdly, we have a situation here in which a professional group on the one hand publicly claims ability to diagnose disease and on the other hand is completely absolved from its mistakes because legally it is neither supposed nor authorized to know such things. Fourthly, the optometrist's customer frequently does not know these things and does not get what he expects to get.

It would seem only fair to the public that optometry either cease its claims or be held legally responsible for its mistakes. What we have is a nice set-up for optometry, but not for the average eyeglass buyer. Every potential eye patient should know all these facts. What he does with this knowledge is, of course, his own business.

The commercial ethics of optometry are also of concern to the reader. This is a problem of sufficient magnitude to have caused all states to pass laws regulating the more obvious abuses for the protection of the public. Some states have forbidden the use of the title "doctor" unless accompanied by the word "optometrist." Lay corporations are barred from going into the business of prescribing glasses. Department and chain stores have got around this restriction by renting space to optometrists. The price of glasses cannot be advertised. Optometrists circumvent this law by advertising the cost of the frames only.

Other states have similar laws, some stringent, some innocuous, none fool-proof, all inconspicuously successful. For it is hard to regulate by law, and to instill ethical standards into, a group in which the accent is on eyeglasses, not eye health — on glasses for people, rather than on glasses for people that need them. This is humanly understandable in a profession over 95 per cent of whose members make their living by selling glasses, not by examining eyes. But the fact that human frailty is understandable does not improve the situation for the prospective patient.

Within the optometric profession itself strong elements, realizing the shortcomings of the situation, are trying to curb the more blatant forms of commercialism. Much has been done to elevate optometric standards within the past ten or

twenty years. But that the success of these efforts is something less than complete is evident to anyone reading newspapers or listening to the radio.

You, reader, are of course interested in what the upshot of all this is going to be and in how it is finally going to affect you. Frankly, I cannot answer that here. There are professional, economic, and psychological imponderables here over which much wiser heads than mine have been puzzling for years. All I can do now is call them as I see them.

Many solutions have been offered. Optometrists suggest a division of the whole field of eye care. "You," they say to the physicians, "take care of all the patients needing medical and surgical eye attention, and we'll take care of all the others." Assuming that such a division were acceptable – which it is not – how would it be arranged? It has been estimated that as many as 25 per cent of all those examined for glasses need some medical eye attention as well.

Even if this figure is too high, there are obviously many people who are not aware of all their optical needs. Who is to decide where a patient shall go if not the patient himself? Will he be required to see a physician first, to rule out all possibilities of disease, and then be referred elsewhere for glasses? Or is there to be a central clearing house to allocate all eye cases? How shall the thing be organized? I can ask many more awkward questions, but I cannot answer them.

Or is the whole solution in the direction of more legislation from without and stricter requirements? History offers no outstanding examples of man's ability to legislate himself into Utopia. Obviously the fact that all states have some type of optometric statute has not been the perfect answer. Requirements for optometric licensure vary all the way from a two-year apprenticeship with a registered optometrist to a diploma from a four-year optometric school. Can ocular needs vary so much? Or is the trouble in the law, ever majestic but a trifle breathless from its efforts to keep up with the ocular requirements of the population?

How about more and better training for the optometric student? Shall there be a closer liaison between medical and

optometric schools? Where is it to begin and end? A couple of years ago Harvard University announced a change in the dental curriculum which is of great potential importance as a possible answer. According to this plan students in the dental school were to share instruction with medical students for three and a half years, then receive specialized dental training for another year and a half, the object being to give dentists a broader medical education in disease and therapy. I do not know what the ultimate fate of this plan will be. These are troubled times, not suitable, perhaps, to educational experiments. And this is a revolutionary step in paramedical education. But it is not a backward step. Are not the eyes as important as the teeth?

Optometry itself is not entirely satisfied with its anomalous position, and some of the better schools have added a few medical courses to their curricula. But this superficial and incomplete medical instruction is not and cannot be enough. Optometry may finally have to decide whether it is to be a profession devoted to eye treatment or a skilled trade that purveys glasses. The eye health of the public will force such a decision; maybe not tomorrow or the next day, but ultimately.

There are some within the medical profession who feel that there is nothing to be gained by broadcasting all this information; that it will only alarm the prospective patient in a situation for which there seems to be no immediate remedy. But I have said nothing here that has not been discussed at length in medical circles and not enough among the laity. Whatever publicity this problem has received heretofore has been all to the public good. Tiptoeing toward a solution is a slow and cumbersome method of advance.

XII

Quacks and Panaceas

This chapter is written in the fond hope that some readers will find it interesting, but there is no illusion about its being "of service to humanity." It starts from the well-established thesis that a goodly portion of our permanent eye disabilities, and all other disabilities for that matter, are due to the wide-eyed gullibility of patients. Frankly, I do not believe that, should the occasion arise, you will do any more about your eyes after having read this than you would have previously — unless you are quite different from most patients whom the eye physician meets.

High-pressure sales methods expose us to a constant bombardment of advertising propaganda praising the rare virtues of this or that nostrum or gadget. The symptoms and diseases are many. The cure is only one — the particular panacea whose blurb you happen to be reading. If only an infinitesimal fraction of these claims were true, there would be few illnesses left for us to enjoy; and even that last haven of refuge, death, might be more difficult of attainment.

The psychological effect of reading a list of symptoms is an awful and wonderful thing. In medical school students suffer through every disease they study in the textbook. The least untoward symptom becomes magnified beyond reason or recognition. It is not remarkable that many of us have become self-prescribers, nostrum-topers, and quack-followers.

Most quacks have a secret formula, disclosed only to them by some supernatural being during a moment of divine revelation. Or they are the direct disciples of some Heaven-inspired individual whose mantle they have managed to touch. This short contact with divinity, even at second hand, always

suffices for a lifetime of inspiration to cash in on human gullibility.

One of the most fertile fields for the quack is the human eye and its frailties. In this field many a racketeering crop has been sown and reaped. All sorts of magical cures and devices clog our footsteps; or should I say befog our eyes? We are sold glasses we do not need and are then urged to buy marvelous cures so that we can dispense with glasses. All sorts of diseases are cured magically – whether you have them or not.

Two hundred years ago a man named Chevalier Taylor had a method for straightening cross-eyes. He pretended to perform a difficult and mysterious operation on one eye and then covered it immediately. The other eye, being the only one used for seeing, became straight (as it would naturally do in all cases where there is no paralysis of the ocular muscles), only to cross again when the "operated" eye was uncovered. Before the hoax was discovered Taylor had collected his booty and departed for greener pastures.

There were many before Taylor, though he is one of the more notorious ones. There have been many charlatans since. Many have taken advantage of our dislike for glasses and our constant search for something that will rejuvenate and transform the imperfect eye into an instrument of optic perfection.

"Shall I ever be able to discard my glasses?"

"Are there any exercises that will help my vision?"

"Can't you prescribe some drops to make me see better?"

Patients are constantly asking these questions, and the usual answers are no, no, and no, respectively.

Few who have reached adult age wearing necessary glasses can discard them without sacrificing vision or comfort or both. And there are no "exercises" or "drops" that can take the place of glasses where needed. This dictum will bring disappointment to many and protests from some. But you cannot explain away a fact, even an unpleasant fact.

From time immemorial men and women – some of them intelligent and highly gifted – have objected violently to the thralldom of spectacles. For instance, Goethe and Samuel Pepys, the greatest of German poets and the greatest of Eng-

lish diarists, were notoriously outspoken against them. A man as eminent as Dr. George J. Beer, one of the pioneers in ophthalmic surgery, was opposed to glasses and even wrote a book to say so. But this was early in the nineteenth century, before we knew the true nature of refractive errors. Beer honestly believed what he wrote and would be the first to discredit his own work were he alive today.

The same cannot be said for others. For subsequently there have been many of agile wit and easy conscience who have not scrupled to take advantage of our objections to seeing better at the expense of our looks. About twenty years ago the now immortal *Perfect Sight without Glasses* was given to the world. It was written by a man who had discovered that many would gladly pay more to be convinced that they did not need glasses than that they did need them. So he brought forth a System.

Reduced to simplest terms, this theory was that all eyes can see normally. The only reason why many individuals do not see well, the author maintained, is that they *try* not to see well. (I know; I couldn't believe it myself, but it's right there.) And all they have to do to regain perfect vision is to "relax." Relax the *eyes?* Rest them? Oh, no! Relax the *mind.* For it is mental, not visual, strain that causes all the trouble. "The cause," says he, "of any error of refraction, of a squint or of any functional disturbance of the eye, is simply a thought . . . a wrong thought . . . and the cure is as quick as the thought that relaxes." This cannot be obtained by sleep or by closing the eyes to rest them, as you might suppose, but only by "relaxation," which has to be "conscious without effort."

So you, dear reader, who are wearing glasses for nearsightedness, farsightedness, or astigmatism, have only yourself to blame. You've been trying too hard, you've been thinking thoughts. Relax, let your mind be a blank – and throw away your specs. But maybe you had better wait, for there is more coming.

According to this book, not only is the effort to see injurious to the eyes, but so are bad thoughts and naughty lies. By the aid of the retinoscope, a little instrument used by all eye

physicians to measure errors of refraction, the author was always able to catch the culprit *in flagrante*. Here is an example:

"A patient 25 years old had no error of refraction when he looked at a blank wall without trying to see; but if he said he was 26, or if someone else said he was 26, or if he tried to imagine he was 26, he became myopic." (So help me, it's in the book.)

And here is another gem I cannot resist including:

"Two little girl patients arrived one after the other one day, and the first accused the second of having stopped at Huyler's for an ice-cream soda, which she had been instructed not to do, being somewhat too much addicted to sweets. The second denied the charge, and the first, *who had used the retinoscope* [italics mine] and knew what it did to people who told lies, said:

" 'Do take the retinoscope and find out.'

"I followed the suggestion, and having thrown the light into the second child's eyes, I asked:

" 'Did you go to Huyler's?'

" 'Yes,' was the response, and the retinoscope indicated no error of refraction.

" 'Did you have an ice-cream soda?'

" 'No,' said the child; but the tell-tale shadow moved in a direction opposite to that of the mirror, showing that she had become myopic and was not telling the truth.

"The child blushed when I told her this and acknowledged that the retinoscope was right; for she had heard of the way of the uncanny instrument before and did not know what else it might do to her if she said anything more that was not true."

Does anyone know what kind of eyesight Ananias enjoyed? And yet after reading this there will still be those who will believe that the wielder of this remarkable instrument had some magic secret that no one else has ever been able to learn.

The exercises to cure bad vision and thoughts went under such titles as "central fixation," "palming," "swaying," "swinging," and "shifting." Staring at the sun with the naked eye, reading in moving vehicles, and thinking of a black dot were

also parts of the system. Essentially they consisted of looking at an object for a few seconds, looking away, then looking back at the object. In short order you were supposed to shift and sway your way to perfect vision without glasses. "Palming" consisted of covering the eyes with the palms for hours on end. This was a particularly difficult maneuver, requiring special training in the office. If the setting sun appeared red or if a star seemed to twinkle, it was not a natural phenomenon, but an ocular misrepresentation – nothing, however, that a little palming or swinging could not help.

As with all cure-alls, there was no end to what these exercises could do. They were good for inflammation of the eyes, glaucoma, cataract, and syphilitic iritis. Not only vision "but all the other senses – touch, taste, hearing and smell – are benefited." Indeed, "all the vital processes – digestion, assimilation, elimination, etc. – are improved." The same exercises cured anything at any distance. For if the patient could not come to the office he could be diagnosed, treated, and cured by correspondence. The book said so.

If this System is still not quite clear to you, maybe this will help:

"When he [the patient] comes to realize, through actual demonstration of the fact, that he does not see best where he is looking, and that when he looks a sufficient distance away from a point he can see it worse when he looks directly at it, he becomes able, in some way, to reduce the distance to which he has to look in order to see worse, until he can look directly at the top of a small letter and see the bottom worse, or look at the bottom and see the top worse."

Now explain it to me, please.

I have quoted from this volume at length because the author of this book worked up a large following of believers. I do not doubt that some reading this book were among that number. I hope so. And I hope that they read this chapter carefully. Although the aforementioned author has gone to his reward, his book epitomizes and is the bible of all the exercise-and-throw-away-your-glasses boys that have followed. Some have adopted the system outright. Others have added

a modern wrinkle or a new contrivance, but the pattern is the same.

For instance, there is the Natural Eyesight Institute, Inc., of Los Angeles, to which the U. S. Post Office Department closed the mails on February 17, 1938, following the issuance of a fraud order. The "Institute" sold a system of eye exercises centered upon a "natural eye normalizer" guaranteed to cure all types of visual difficulties and to obviate all necessity for glasses. The "normalizer" was a gadget which, when placed over the eyes, was supposed to work its wonders by rotating the eyeballs and stretching the eye muscles in all directions. "It massages and manipulates the eyeball in a most delicate and delightful manner." But, alas for trusting humanity, not only are such manipulations worthless, but it was brought out at the trial that about all the "normalizer" could do was to wrinkle the skin of the lids, I do not know how delicately or how delightfully. It could not possibly have had any effect on the movements of the eye muscles.

The punch line of this little anecdote is in the judge's summation: "Moreover, the promoter himself is still obliged to wear glasses and has not been able to do for himself what he advertises to do for others in the matter of discarding same."

There are other systems, including one from England — the brotherhood is universal, you see — that cure you of eyeglasses by "natural methods." Not only are palming, swaying, and shifting used, but "blinking," "flashing," and the "long swing" have been added to the exercise vocabulary. Some have even strayed so far from the fold of the original High Priest as to recommend rhythmic contortions of the body with the eyes closed. In order to get the full benefit of these jitterbug gyrations, attendance at the author's clinic for instruction is, of course, necessary. And each one modestly admits that his exercises cure various diseases, including blindness.

But why go on? The stories are practically identical. This ability to swing away farsightedness, blink away nearsightedness, and palm away astigmatism is a wondrous thing. I wish I had the gift. I'd throw my glasses away tomorrow. So would

any sensible individual. But I know of no one who has ever been able to sway hard enough or swing long enough to do it, although some think they have. And such is the nature of the human animal that some individuals, after years of "exercises," still believe that they simply did not persevere long enough. Apparently the average lifetime is too short for a complete cure.

Now where does this leave us, the vast army of eyeglass wearers? If we want to see and be comfortable, we are just where the "exercise" mongers found us — with our glasses perched on our noses.

Excluding serious pathological conditions, most of us suffer with our eyes because of refractive errors. Other important causes of eye difficulty are presbyopia or old sight, poor lighting, and ocular muscle disturbances. We know that refractive errors are static, anatomic conditions upon which exercises, drops, or a laying on of hands have not the slightest effect. Nor will prayer help much either, brethren. Whatever changes do occur are due to the slow deteriorative process of growing older. And we have seen that the same thing accounts for old sight. I will admit that it is much easier to believe that a few exercises can do away with all this nonsense. But they cannot; and it isn't nonsense.

It has been pointed out that eye exercises are legitimate and of value in certain types of muscle deficiencies amenable to orthoptic training. Glasses are always worn in such cases if necessary; usually they are necessary. Unfortunately, even orthoptic training has fallen here and there into the hands of non-medical men who promise wonders but never seem to work them.

We have also seen that human vision is a compound of many things: inherent visual acuity, education, experience, training, memory, and a host of conditioned reflexes acquired in reaction to our varying necessities and environments. The old trained woodsman sees better in his element than the young, clearer-sighted city-dweller; the experienced proofreader can detect typographical errors that would escape the tyro of equal or better vision, etc., etc. The "trained" eye is

largely the trained mind behind the eye. In other words, the human eye is not only a camera, but it is also a seeing apparatus attached to an interpretative brain. Visual function depends on both these components, and a well-educated brain can sometimes make up for a poorly functioning eye.

Furthermore, just as the uneducated nose can be taught to spot the finest differences in perfumes or lethal gases, just as the palate can be taught to detect unerringly the most delicate variations in teas, coffees, and vintages, so can the eyes be trained to improve their functional discrimination and speed. In the armed forces raw recruits are taught to become experts at detecting hostile planes, tanks, and ships at a glance. The same holds true in the more peaceful pursuits in factories, offices, libraries, etc.

But, mark you, such training still leaves the individual with his nearsightedness, farsightedness, or astigmatism. He must still wear his glasses. He has simply learned how to use to better advantage whatever visual equipment he has been blessed with. Such eye training is valid and effective, and many avenues of usefulness are open to it. With greater knowledge and experience it is entirely possible that such visual education will be used more and more and that it may ultimately lead to the solution of visual problems hitherto considered insoluble.

For example, a recent report by the R.A.F. Orthoptic Clinic contains some cheering news and points the way. It describes work done on pilots referred for corrective treatment of eye "defects associated with visual judgment and certain types of eyestrain." Ninety per cent of these men went back to their squadrons cured after only three weeks of treatment. Here again the eye surgeons stressed the point that such treatment is not for the reduction of errors of refraction or the cure of disease, but only for improving the ability of the eyes to function properly. Hence to say that exercises can relieve us permanently of poor eyesight and glasses is, at the very least, wishful thinking. Often it is much worse than that.

It is funny, isn't it? We take our watch or car to a good mechanic for repairs; our eyes we entrust to anyone with a

quick tongue and a glib promise. Yet few reading these lines do not have a trusted physician who could advise them and straighten out their difficulties.

How do these "exercise" artists keep going year after year? I'm not sure. I haven't the secret. Some of their alleged cures are among those wearing unnecessary glasses by benefit of cursory non-medical eyeglass examinations. Their continued presence may be partly explained also by the fact that many of their victims are adults who are slightly nearsighted. Such people, as we have seen, rarely have eyestrain and can usually dispense with their glasses at a sacrifice of distant vision only. For instance, the following phrase from a recent letter is typical:

"I have a slight case of myopia, I believe. I acquired glasses and they were an aid. But on reading ________'s advice, I discarded them and although not yet being able to carry out the entire cure as laid down, I feel better."

It is a small matter for a gifted salesman to talk people into believing that they feel better. They want to believe it.

Then there are a few farsighted or astigmatic people who have good distant and near vision, but who need glasses to relieve them of the strain of focusing on near objects. They can be talked into discarding their glasses for a while. *They* can be fooled, but not their eyes. Sooner or later the strain becomes unbearable, and glasses have to be worn again.

Can any reasonable person believe that eye physicians would deliberately fasten glasses on to themselves and their patients if they knew how to avoid them? Is it possible that five or ten or a hundred individuals only should be selected by the Almighty to receive the knowledge that might relieve all of us of the necessity of wearing glasses? Are the millions of people now wearing glasses, including eye physicians, all stupid and neurotic?

And yet these supposed wonder workers continue to thrive in our midst. I'm afraid it's the old story of the high pressure personality versus gullibility, the perfect commercial interaction between the ability to sell and the desire to be sold. And, finally, it is a transaction in which heartlessness and

venality are implicit. For it is cruel to deprive human beings of conveniences that make life easier to live, that prevent accidents due to poor vision, and that may even forestall or delay the onset of some of the eye diseases of late middle life. The "exercise" experts will always be with us, because they will always find victims credulous enough to be mulcted.

Maybe I'm too pessimistic. I hope so.

Another type of racket battens on the generalized phobia of cancer. While this is not limited to the eye, some expert gentlemen seem to have made a specialty of "eye cancer." The notorious "Glimmer Racket" has received some publicity, but not enough. It is worthy of complete presentation as it appeared in the Journal of the Missouri State Medical Association of December, 1936. This material was furnished by the Chief Inspector, Post Office Department, Washington, D. C.

In the Glimmer Racket there are persons known as "finger men" who travel about the country selling eyeglasses. Some of them are licensed opticians. They sell very cheap glasses for exorbitant prices. Sometimes they sell glasses worth not over \$5.00 for more than \$100.00.

The fake doctor who first gets into the house introduces himself under the name of some nationally or internationally known physican, surgeon, or oculist, and claims to be connected with some well-known optical house.

The fake doctor gets out his kit and instruments. He fits lens after lens into the testing frame and pretends that no satisfactory results are obtained. He appears to be worried over the case, and from much practice he acts the part well. He finally tells the victim he cannot make a fitting, as something is unusually wrong with one eye. He informs the victim that he has an eminent eye specialist with him in his car and suggests that he be called in to make an examination.

The alleged eye specialist is called in from the doorway and told to bring his kit containing his instruments. They let the victim see clearly that there is no collusion between the two. The "doctor" is dressed to play the part of a successful professional man from the big city or a famous institution. The first man tells the fake doctor

his troubles – how the whole matter has baffled him – and asks if he will make an examination without charge. This he agrees to do.

The fake doctor then makes his examination. He says little or nothing. He shakes his head as the examination progresses, indicating the discovery of some serious trouble. He finally announces: "It is no wonder you cannot fit glasses to this eye. It is in a very bad condition. There is a 'cancerette' on it. Unless it is removed very shortly it will either go to the brain and result in death, or paralysis will follow. There are only a few hospitals in the country where such cases can be successfully and safely operated on."

After further discussion as to costs at such institutions, the fake specialist is induced to undertake the operation, stipulating absolute secrecy.

The fake doctor has the patient lean back. The head is dropped farther backward. An eye-dropper is inserted into a green opaque glass bottle, heavily corked, and a very few drops of the precious liquid are withdrawn. After these drops are put into the eye, a blunt pair of medicated-cotton-tipped medical tweezers are used to rub the medicine around in the eye as an occasional drop is added. The fake doctor will request the mate of the victim, if present, to procure some hot water.

During the few intervening moments of absence, this faker will remove from his mouth a piece of rubberoid material (which he had placed therein at the time he ostensibly went to the car for his "leaflet") and spreads it over the patient's eye. He continues to simulate the rubbing of the eye with the tweezers, and after this tissue rubber has been spread over the entire eye to the fake doctor's satisfaction, he will call any one present and point to the wonderful effect of his so-called "liquid radium" in drawing this cancerous growth to the surface, explaining it is coming out by its roots. Very shortly, he utilizes the tweezers to catch hold of the rubber, which is then slowly withdrawn from the eye.

This so-called cancerous growth is immediately thrown into a fire, or in some other manner destroyed by burning. If the credulous folks desire either to preserve it or to inspect it closely, they are impressively told: "This is a most virulent poison. It is so deadly that it must be destroyed by burning. If I were to throw it into the yard and one of your chickens ate it, it would not injure or kill the chicken any more than the other filth chickens eat, but if you should later kill that particular hen, then all who ate of it would get cancer of the stomach!"

If the swindlers are successful in obtaining a large amount of money for the pretended operation another visit is made to the victim in about two weeks by two different members of the ring, one claiming to be a noted eye specialist and the other a judge. These men represent that the "specialist" who performed the operation was killed in an accident, but lived long enough to make the request that an examination be made to determine whether the operation had been successful, and directed that the money paid for the operation be returned if it was not a success. The pretended judge falsely represents that he is selling the estate of the deceased doctor, and that he stands ready to make the refund if the operation failed.

An examination is then made on the pretense of determining whether the operation was successful, following which the new fake doctor announces: "I find that you have 'cancerosis' of the eye in the very worst form, and unless something is done at once you will be paralyzed and probaby lose your life. But you can be cured. A renowned German physician named Krupp invented a belt which if worn will cure it. The belt gives off radium rays and is a sure cure, as it corrects the condition of the blood."

The victim is told there are only a small number of these belts in existence as Dr. Krupp died without leaving the formula. It is claimed that the belts are in the possession of a few renowned hospitals and that the "doctor's" own hospital is one of them. A child related to the "judge" is at present wearing the belt, but as the child is practically cured of infantile paralysis, the belt will be available in a short time. The victim is told that he can rent the belt for a dollar a day, but because of its great value he must post a deposit for its safe return. It is understood that there will be no charge for the belt if it does not effect a cure and that the deposit will be given back when the belt is returned.

In this way victims are induced to give the fake eye specialist large amounts in the form of checks or cash as security, in the belief that the deposit will be held until the return of the belt; but the fakers cash the checks as quickly as possible and seldom deliver the belts.

This racket seems to be confined mostly to the rural communities. But charlatanry knows no geographical limitations, nor have our rural regions a corner on credulity. This particular racket has been described in circulars issued by the U. S. Post Office Department, which has gone after these swindlers.

Some have been convicted, others are awaiting trial, many are still roaming the country blithely robbing a trusting, foolish public.

Beware of the man with the "sure cure." The panacea is the trademark of the quack and charlatan. Reputable physicians with hundreds of years of scientific research and clinical experience behind them do not guarantee cures.

The cataract has also received its meed of recognition from the slickers. Every once in a while drops guaranteed to "make cataracts disappear" are brought out. Often there is an apparent improvement, due to an ingredient in the drops that dilates the pupil and lets more light into the eye. The trouble is that when the effect of the drops has worn off the light – and the promoter – disappear. The cataracts do not. The same goes for a hoax more prevalent some time ago in which electricity was supposed to make cataracts melt away. They didn't, but the enterprising healer did – after collecting.

Several years ago a pair of inventive gentlemen came out with glasses – the trail always leads back to glasses – to prevent cataracts. The invention was based on the theory that all cataracts are caused by the "hot" infra-red rays of the sun, which in some way coagulate the substance of the lens of the eye. These glasses were supposed to "cool out" these rays. If this explanation were true, all our eyes should be cooked as hard as a ten-minute egg at the end of a summer. The idea was as ingenious as the theory was wrong.

Of lesser importance, though by no means insignificant, are the hundreds of patent collyria, eye lotions, washes, drops, creams, and oils that fill the drug shelves and flow over into the drugstore windows. According to the labels they are supposed to make the eyes glitter and sparkle; they beautify, glorify, and clarify; they fortify, freshen, stimulate, and "lift"; but, above all, they rejuvenate by removing old wrinkles and preventing young ones. Many of these claims are more remarkable for volume than for veracity.

Some of these marvel waters are to be applied on a specially colored and prepared soothing pad over the closed eyes. This is not a bad idea. But the same maneuver with a face

towel wrung out in cold water is equally effective. Closing the eyes rests them, and the cool moisture will feel refreshing. Nor will the eyes care what color the pad is. You have an endless, costless source of eye comfort right out of your water-tap.

And then there are the vitamins. No man who reads newspapers or periodicals has escaped them. We are all assured of long, healthy lives if we eat this food or drink that beverage crammed full of vitamins A to Z inclusive. After digesting some of the claims made for them one begins to wonder how we ever managed to live and see before the concentrated vitamins were made available to us, not only in all our foods and drinks, but also in soaps, face creams, liniments, hair tonics, and other cosmetics where their value is, to be generous, highly questionable.

To many the vitamins have become miraculous panaceas for all ills. In this connection an anecdote by Dr. Morris Fishbein, Editor of the Journal of the American Medical Association, is particularly apt:

The teacher asked a little boy to write an essay.

"What shall I write about?" he asked.

"Just write what is in you," she answered inspirationally.

The boy thought that over and wrote: "In me there is oatmeal and orange juice and an all day sucker." Then he added, "There is also my heart, my liver, my stomach and the vowels which are A, E, I, O, U."

"That," concludes Dr. Fishbein, "resembles the average person's knowledge of vitamins."

The eyes have not escaped the attentions of those who are out to save us from our ignorance in spite of ourselves — at a nominal cost. Unfortunately, many of the claims made for the vitamins in this connection are compounded of a small — very small — kernel of truth well hidden in a mass of optimistic imagination.

The importance of vitamins to the eye is undoubted. A tremendous amount of work and study is being done, and we are learning about them so rapidly that before this book has

seen many months much of what is said here may have to be revised — upward, I hope.

The relation of vitamin A to night blindness has been discussed. There is some evidence that this vitamin is also of value in certain diseases of the cornea and retina. There appears, too, to be a connection between certain fractions of vitamin B and the health of the cornea and optic nerve. The necessity of some of the vitamins to the growth and development of the lens in rats and other laboratory animals has been studied and proved. On the other hand, there is no unequivocal evidence that feeding these same vitamins to human beings with cataractous lenses does a particle of good. Vitamins B and C have been suggested as prophylactic medication for incipient and early lens opacities, but it is much too early to say anything about the subject. Vitamin D has been mentioned to relieve myopia. Its value is still being tested and disputed.

You will note that the previous paragraph is written gingerly, with many qualifications. That is because we know so little about the vitamins as yet that categorical statements are hard to make. We are still groping, but in the right direction.

The eyes of an individual suffering from avitaminosis will be affected as much as the rest of the body. But the treatment should be under expert supervision. This is doubly true where specific diseases of the eye are concerned.

At the risk of being repetitious I must state again that anyone who eats a normal, balanced diet gets all the vitamins he needs in his food. Babies are fed vitamins because theirs is a limited diet. The normal, well-fed adult rarely needs them. The fire of enthusiasm with which vitamins have been greeted in some non-medical quarters has generated too much heat and too little necessary light on the subject.

For years tons of printed matter have been distributed and millions of cubic feet of carbon dioxide have been expelled into the ozone in an effort to warn people about the worthless nostrums and quackeries that beset us from all sides. Nevertheless, throughout the ages a health-careless public has allowed itself to be gulled by charlatans and their miraculous

panaceas. There is little evidence that we have profited by our experiences.

Too many bring their troubles to the doctor as a last resort. They delay the evil hour as much as possible. They exhaust their own bag of home-made tricks, act on the advice and receive the ministrations of all types of misguiding lay individuals, and finally seek medical aid in desperation. Not all, but too many.

It has been truly said that medicine is the only profession that is working as hard as it can to do away with the reason for its own existence. But there seems to be no prospect that doctors will be out of a job in the immediate future — unless there are a couple of well-hidden millennia around that well-known corner.

XIII

Hygiene and First Aid

The normal eye needs no home treatment, the abnormal eye needs much more than that. The reader who expects to find here an elaborate ritual of systematic hygiene for the eye is going to be disappointed. The healthy eye gets along nicely without hygienic care from us. It makes its own.

Better than any other organ in the body, the eye is guarded by its own sanitary and protective mechanisms, which serve it not only through all the ordinary wear and tear of daily seeing, but also in most of the unusual vicissitudes that life throws on it and at it. This arrangement is indispensable, because, though the eye is perhaps the most delicately adjusted organ in the body, it is built for a lifetime of use, cannot be traded in for a new one, and must not be left to the mercies and amateur ministrations of the average eye owner, no matter how well-intentioned.

Earlier we saw how the eye occupies a shielded position in the head. We spoke of the lids, which are the protective curtains of the eye, ready to close at the first sight or sound of danger. Loud noises, flying missiles, glaring lights, all make the lids shut instantly. It is remarkable how often serious injuries of the face occur with the eyes themselves remaining uninjured, unless the lids are penetrated by some sharp object.

But the lids close not only when there is danger. Regularly from three to six times a minute they snap shut for an instant in order to spread over the eye a thin mucoid secretion supplied by the inside lining of the lids, the conjunctiva. This normal lubrication by blinking keeps the eye moist and prevents friction between eye and lids. There are certain diseases and injuries in which the lids do not close properly. In some cases the eyes tend to protrude too far for the lids to cover

them completely, as in toxic goiter. When this protection of the lids is lost the eyes frequently suffer from exposure and infection unless precautions are taken to restore the lost lid function or to substitute for it.

The eyelashes that line the edges of the upper and lower lids are curled upward and downward respectively so as to catch all particles that may fall into the eye from above or fly into it from below. They are especially heavy on the upper lid because that is where most of the trouble comes from.

The cornea, with the rest of the front of the eye, is so sensitive that the tiniest foreign body is instantly felt, often painfully. Immediately the lids close in an effort to wipe away the offending source of irritation.

This, then, is the automatic ocular cleaning and lubricating system.

There is also an automatic sprinkler system that provides for the cleanliness and health of the eye. From the point of view of efficiency and mechanics the tears, which are the irrigating fluid, make a fascinating study.

Tears are constantly being supplied in minute quantities. Technically, therefore, we are always crying, because our tears are always flowing. They come from a small gland that lies safely cuddled in a little hollow just behind the upper outer angle of the eye socket. The tear fluid is carried over the eyeball by the normal blinking of the lids. It then passes through a minute opening in the skin of the inner corner of the lids and down through a narrow channel into the back of the nose and throat. This process goes on constantly, but usually we are entirely unaware of it, so efficiently is it carried out.

Occasionally the tear duct becomes obstructed, especially in older people. Then we begin to realize how large is the daily quantity of tears actually produced by the normal eye. Constant wiping is necessary to keep it dry. Ladies who manifest their enjoyment of a particularly sad movie or play by shedding copious tears have to wipe their eyes as well as blow their noses in order to remove the excess product of their joyful lacrimation. For when the supply produced is too

great, the tear mechanism does all it can, and the rest spills over on to the cheek.

But crying in joy or sorrow is the least important function of our tears. It is merely a psychic luxury and another mark of our superiority over the lower animals. The main purpose of the tears is to wash the eye and prevent infection. Smoke, dust, and other foreign substances also make the eye "cry," and this production of eye fluid helps sweep away the foreign matter and keep the eye clean. In cold weather out-of-doors and in a strong wind the eyes also tear excessively to provide sufficient warm moisture for the external ocular structures.

The tears are even more than a self-made eyewash. They have antiseptic properties that have saved our eyes from serious infection many times without our knowledge. The irritating antiseptic content of the tears is quite evident when a person has been crying for some time. The evidences are hard to eradicate, because the skin of the lids and cheek becomes red and puffy as a result of irritation by the tears. And yet it is a remarkable fact that the delicate tissues lining the eyeball itself, and bathed in tears for a lifetime, show no ill effects. This discrepancy is just another of nature's little tricks. It is also seen in the lining of our stomachs, which will accept, with no apparent permanently bad results, fluids capable of eating the varnish off furniture – that is, if they are not taken in too large quantities.

In the face of all these natural provisions, the question of many patients concerning a wash for the normal eye seems rather pointless. But there are many who feel cheated when told that their eyes need no washes. They have been accustomed to use them all their lives, and they feel lonesome if deprived of their daily unnecessary ablutions. Most of these washes do no harm – in the normal eye. The danger, and it is a big danger, is that for many people valueless eyewashes are the first port of refuge for all ailing eyes, whatever the cause. Boric acid and eye trouble, for instance, seem as irrevocably linked together as ham and eggs or scotch and soda. This trust

in boric acid is perhaps one of the greatest wrongs done the defenseless human eye. Sprung from I know not what illegitimate sources, ripened in the garden of hearsay and yellowed in false tradition, the hoary myth of Boric the Omnipotent waxes more hale with the years. And the probabilities are that it has done a good deal more optical harm than good.

At its best, boric acid is an innocuous, mildly antiseptic eyewash, not much better than the same amount of sterile water. If it were accepted and used as such, there would be no objection to it. But if I seem to inveigh against it too strongly, it is because too little is known about the eyes permanently injured by the fanatic faith with which misguided human beings dive for this presumed panacea at the first indication of eye distress.

Many of our eye ills are of the minor, self-limiting variety that get better in spite of anything we do. Boric acid or some other eyewash gets the credit for these. The severe cases proceed to get no better despite Niagaras of cold, lukewarm, and hot solutions that might as well be poured down the back — anybody's back — as into the eye. Too often acute, serious cases of intraocular inflammation are seen with a history of seven to ten days of self-dosing with home-made or patented eye solutions before a physician is consulted. Meanwhile valuable time is lost and serious damage is done.

It is hard to break an age-old habit. And this is written in the full realization that what has just been said will have little effect on the drugstore sales of boric acid and other favorite eyewashes, to which, it is again emphasized, there is no objection provided they are not misused and little is expected of them.

Habit is so strong that I shall even add one eyewash here for those who insist that they must have something besides pure water to make their eyes "feel clean." A teaspoonful each of table salt, soda bicarbonate, and borax, together with a tablespoonful of pure glycerine dissolved in a quart of boiled water, will make an eye solution as effective as any fancy-priced proprietary mixture. It has no more specific medicinal

value than boric solution or any of the other eye solutions. But after a long day in the sun and wind it is refreshing when applied cold. So is water.

It may now be briefly stated that the conservation of the health of the eye consists, in general, of correction of visual errors, proper lighting, sufficient rest, and adequate medical care when necessary. These have all been discussed separately in preceding chapters.

An eye needing glasses is working under a strain just as much as you would be if you walked around all day with a fifty-pound weight on your back. It is laboring under abnormal conditions and will not give the best of which it is capable; neither will its owner. Let me repeat that all the eyewashes in the world will not flood your eyes with light or make up for the lack of it. Added years mean added light requirements for aging eyes. More light will not restore youthful vigor, but it may compensate for it to some extent and will certainly keep your eyes working more efficiently and more healthily. On the other hand, too much light and glare outdoors should be guarded against by dark glasses.

A strenuous day of continued work in the office or on the golf course is not the best preparaiton for a long night of reading or other close visual application. The eyes tire as we tire and benefit by occasional short rest periods just as the rest of us does. Most of us cannot walk all day without tiring. Why expect the eyes to do constant work without becoming fatigued?

The food we eat, the fluids we drink are just as necessary for the replenishment of the eye tissues as for all other bodily tissues. Prolonged lack of necessary minerals, vitamins, and hormones are just as bad for the eye as for the rest of the body. So is a long, debilitating disease. That is why doctors often forbid prolonged reading after long and exhausting illnesses. The healthy eye in the healthy body requires little unusual attention. But it does need the benefit of the same regular health check-up that you give your teeth.

It would require a volume many times the size of this one to discuss all possible injuries to the eye. This cannot be a

vade mecum of home treatment. In fact, it is hoped that, having read this book, you will see the value of getting skilled help as soon as possible. First-aid treatment, however, is important in a few special cases and does need attention here.

The most common eye condition requiring first aid is the "cinder" in the eye. This may be a particle of wood, glass, metal, cement, or any other hard substance. The first and worst thing most of us do here is rub the eye. It is a natural action and hard to resist. But the next time you get something in your eye think of what may happen to the delicate tissues lining the inside when a hard, sharp particle is rubbed against them.

Frequently the eye itself gets rid of its unwelcome visitor by the natural blinking of the lid. If it does not, try to resist the inclination to rub and wash the eye out with some warm water in an eye cup. If this is also unsuccessful, then have the foreign particle removed soon. If it lodges on the inside of the upper or lower lid it can be easily removed with a moist cotton swab on a toothpick by anyone who can turn a lid.

Sometimes, however, a foreign body may become stuck to the surface of the cornea. Rubbing will only force it in deeper. Or it may be completely overlooked by the neighbor next door or the corner druggist whose help is sought. Both are undoubtedly estimable gentlemen, anxious to help. They may even be adept at turning the lids over. But they frequently overlook a cinder which is right in the center of the cornea and needs no lid-turning to be seen. Even if you do not rub it, there is danger here that the normal movement of the lid will press the foreign body deeper into the cornea. It may even stop hurting for a while. But if it is left in too long, infection will set in and an ulcer of the cornea will surely result.

The foreign particle may be so small that it cannot be seen with the naked eye; it may require special instruments to be located. Sometimes a scratch of the cornea or an eyelash in the eye may feel just like a cinder. Both may be overlooked by an amateur and will give you miserable hours while you wait in vain for the "cinder" to come out by itself. Get help.

Injuries to the eye are frequent. Despite all the protection that nature has furnished us, we manage to circumvent her most ingenious safety devices in numerous ways.

Since the time of the Caesars and before, raw beefsteak has been used for the eye that has come out second best in an altercation with a fist, brick, door, or other unfriendly object. You will find that the "black eye" is much better off during the first twenty-four hours with compresses of cold water applied every three hours for about twenty minutes to a half hour each time. This will tend to limit the swelling and discoloration. Later, hot compresses applied regularly will tend to absorb the tell-tale markings more quickly. And the beefsteak does more good when eaten. If there is the least suggestion of persistence of pain or impaired vision, medical attention should be sought at once. The humorous "shiner" can have some sad consequences.

Smoke, dust, heat, and other irritations may cause transient redness of the eyes, which is of little consequence as a rule. Any sort of bland eyewash is not objectionable here. Usually the trouble clears up spontaneously, but if the redness does not disappear in a few hours you had better see why.

Hot oil, fire, steam, sparks, acids, and other chemicals splashed into the eye are a serious menace to vision. The best immediate treatment is to wash the eye out at once with large quantities of plain tap water, put a liberal amount of pure white vaseline right into the eye, cover it with some clean gauze, and run, don't walk, to the nearest doctor. In case of serious injuries such as blows and wounds by sharp missiles or instruments the eye had better be covered with a loose sterile gauze dressing immediately and rushed to the nearest physician. Prompt help may mean the saving of an eye.

Not all injuries to the eyes are the result of violence. Reports of serious trouble in the eyes from carelessly used dangerous hair-dyes have been published. And patented weight-reducing drugs carelessly and indiscriminately used have produced cataracts in many eyes. There are many similar true stories, too numerous to catalogue here. The moral seems to be that a little sound advice obtained before embarking on

the uncharted sea of self-medication may save you a long, rough, and unhealthy journey.

Another set of eye injuries usually resulting from carelessness is due to the invisible ultra-violet radiations (photophthalmia). The popular use of sun-tan lamps in the home has occasionally resulted in eye trouble due to exposure to the short-wave rays generated by the lamp. The eyes become red and weepy, light is hard to bear, and there may be a discharge of purulent material. As treatment your physician will prescribe irrigations with a bland eyewash, cool compresses applied over the eyes, and protection from light. The pain can also be mitigated to a large extent by proper medication. The whole business can be avoided by wearing the protective goggles that are usually supplied with the lamp. If they are not supplied, get them.

Snow blindness, which is neither blindness nor due directly to the snow, is a similar condition. It likewise is due to the ultra-violet radiations reflected from unrelieved wide expanses of snow into the unprotected eye. It, too, is really an inflammation of the conjunctival lining of the eye together with the superficial cornea. Involvement of the corneal nerves gives a dread of light and an extremely painful pair of eyes. This eye affection has a bad reputation, not entirely earned. It may be frightening and painful, but it is neither serious nor permanent unless there are frequently recurrent exposures. Snow blindness also can be entirely prevented by simply wearing proper sunglasses when hunting or skiing in winter. The sun-goggle is as much a part of the equipment of ski-troops, for instance, as the skis themselves.

With sunlight reflected from snow so inimical to eyes, patients occasionally ask why people with unprotected eyes do not suffer more from the sun's rays ordinarily. This was partly answered in Chapter VII. In addition it must be remembered that few of us go around staring directly at the bright sun. It's not only foolhardy, but also hard to do. Also a wide expanse of pure white snow is probably one of the best of nature's reflectors of sunlight. The black earth and rich green vegetation of nature, as well as the drab city streets of man,

reflect comparatively little sunlight. Hence the absence of such casualties under ordinary conditions.

Many snow scenes are filmed in temperate California. A condition of the eyes can be acquired right there in the warm studios that is indistinguishable from snow blindness. Commonly called "klieg eye," it too is due to the short-wave radiations from the powerful lights used in movie-making. In industry, workers who handle acetylene torches with insufficient respect develop a similar condition, due to a similar cause.

Whether acquired at work or at play, the symptoms are in all cases the result of improper exposure of the eyes to concentrated short-wave radiations. With proper care they are usually transient and leave no permanent traces.

I do not know whether this comes under hygiene or first aid – probably both – but be sure that the hands are clean when working around any eye, including your own. Practice the same care about handkerchiefs and towels used on eyes with foreign bodies in them. Otherwise, a cinder will be carefully removed and a pinkeye as carefully substituted. Good intentions and dirt are constantly being poked at the eye. It is hard to say which is more harmful.

In short, the eye is a self-cleansing organ which ordinarily requires little care. About all the average man should do with his pair of eyes, aside from the periodic health examination, is open them in the morning, close them at night, look through them during the day, and holler for help when anything goes wrong. This may sound drastic, but in the long run the eyes will be much better off for it.

A more detailed discussion of the commoner diseases of the young and the old eye and their care will be found in the following chapters.

XIV

The Young Eye

This is about children, but for adults.

Children depend on us. They are not yet old enough to assert their inalienable rights to have and to hold their eye infirmities without meddlesome interference from doctors. That is left to us older beings. Parents may do as they please about their own eyes, but they cannot neglect the eyes of their children. The race is too swift and the battle too strong these days to add an unnecessary eye handicap to the young individual's already heavy burden.

Infants are born with farsighted eyes that cannot see. This is literally true, for, like kittens, babies are blind at birth. During the first few days of life, however, they learn to see enough for lights to attract them and moving objects to interest them.

But this early vision is not the highly perfected faculty that it is later to become. It takes several months before the eyes learn to work together, and it is not until the end of the sixth or seventh year that the fusion faculty has become completely developed. Color vision is also acquired after birth and is not fully developed until the child is about one and one-half years old or later.

The very color of the eye undergoes change with growth, so that the blue or gray iris with which all babies are born — even Negro babies — changes to brown in the majority of cases during the first year. It is, then, some time after birth before all the refinements of good vision are acquired. Unfortunately there are some children for whom not all of these developments occur. Some remain color blind, others are minus a fusion faculty, and many even fail to acquire good vision in one eye or both eyes.

It is during these early growing years that the child's eyes require the most careful attention. In this formative period minor visual errors and diseases are often easily corrected. On the other hand, this is the time when bad visual habits that are unchecked and defects and diseases that are neglected may leave their permanent mark on the whole life of the adult-to-be. Hence the necessity for a medical eye examination of every child at the age of three, certainly not later than four, even if there seems to be nothing wrong with the child's eyes. If no defects requiring immediate attention are found, the child should be returned to the doctor just before entering school, to make sure that there have been no untoward developments in the interim. And this should be repeated again before the child enters high school. These three examinations are a minimum, will assure the maintenance of normal visual efficiency, and should be done even in the apparent absence of all eye symptoms.

The first and most important object of all these examinations is, of course, to get an accurate idea of the child's vision. Parents will often delay an eye test because they think that the child is too young, that it "will not give the right answers." This is a mistaken impression. With the help of drops it is possible to get an accurate estimate of the refractive status of even a tiny infant. Also, a good idea of visual acuity can be obtained by the child's ability to follow a light or to detect at a distance small colored objects such as marbles and other small toys.

At the age of three or four the child is old enough to help in the examination. It can now recognize pictures of animals and other common objects of various sizes on a graduated vision-chart. Or it may be shown a chart with the letter E in various positions and asked to tell in which direction the arms of the E are pointing. A still older child presents no difficulties at all to the examiner.

Nor is it always wise to delay an examination because the child's eyes "look all right." It is not always easy to detect eye defects in an infant. And even in older children poor vision or a small amount of squint may be overlooked by the most care-

ful parent until it gets worse and becomes too obvious to miss. In examinations of series after series of children under six years of age, approximately 10 per cent have been found to have some sort of eye defect, requiring correction, that was unsuspected. In the ages between six and twelve this percentage is approximately doubled. It is during this period, you will remember, that nearsightedness increases from 6 to over 15 per cent.

Many schools now do routine eye examinations on children at regular intervals, and some parents have learned to depend on them. These are certainly an improvement over the old days when none at all were done. But over half the children of the country live in rural communities where school social service and nursing are not well organized, and the eye health of children is consequently neglected.

And even in the urban centers important eye deficiencies may be overlooked. School eye tests are not entirely an unmixed blessing. What dilutes the blessing is that nurses and teachers have become the eye guardians of large portions of our younger population. And their claim to ophthalmologic omniscience is usually based on the distant-vision chart only. We have seen that good distant vision is by no means proof that there is nothing wrong with the eyes. In unskilled hands even the best vision tests, apparatus, and intentions fail to screen out all the children who need an eye physician's attention. They must not be depended on too much.

Some of the things to watch out for in a young child are frequent blinking, frowning, and inattention. A child who is constantly rubbing the eyes or screwing the lids together or complaining of headache or aching eyes may not have eye trouble at all, but it is wise to check up and make sure. More noticeable signs, such as "granulated lids," frequently red eyes, and styes, obviously need attention. Unfortunately they do not always get it early enough.

These early years are crucial not only from an ocular but also from a psychological standpoint. It has not been sufficiently well advertised that the apparently slow, stumbling, stupid child is often retarded by nothing but poor vision.

Lack of glasses, insufficient light, and reading matter with type too small for the visual capacity of the child all contribute to visual fatigue, headache, nervous exhaustion, and a laggard mind. The transformation from a little devil to a little angel is often accomplished by nothing more miraculous than an ordinary pair of eyeglasses.

With approximately one school child in every five having some type of refractive error needing correction, glasses for children are frequently prescribed. Their value is so well recognized these days that they usually constitute no problem. Occasionally, however, the adoption of glasses becomes a difficult and soul-searing procedure – not for the child who is going to wear the glasses, but for the mother, and frequently for the physician. It is the child who needs the glasses, but it is the parent who requires the convincing that they must be worn.

There are many more pleasant things in life than to have to order eyeglasses for a pretty, blue-eyed, blond-haired little tot. On the other hand, everything considered, there are many worse things that could happen; but not, apparently, in the opinion of the dear mother. There are parents who regard little Mary's or Johnny's need of glasses as nothing short of cosmic calamity. Instead of suffering in stoic silence, they raise their lamentations to heaven. As a result a usually compliant child is changed into a little rebel.

Few children object to wearing glasses; as a rule they are quite acquiescent and happy with them if left alone. But the suffering parent finds manifold objections: the child is too young, the child will become accustomed to them, the child will be hurt at play, and so on and on. Such an attitude only makes it more difficult for the youngster.

Parents should know that babies of sixteen months and even younger can wear glasses with safety. Older children who need glasses and who wear them at play are safer with them than without them. The child runs more risk of being hurt because its vision is poor without glasses than with the good vision that glasses provide, and injuries to the eyes of glass-wearing children are not common. For the particularly

fearful parent there are now available glasses made of non-shatterable material.

So many children wear eyeglasses these days that the derisive "four eyes" of yesteryear rarely disturbs the modern child. Not only is it easy to get children to wear glasses, but, once having worn them, they see so much better that they learn to value the glasses and are uncomfortable without them. This is especially true of the nearsighted child, to whom a whole new world is opened by glasses.

The highly myopic child presents a special human problem. He or she must not be made to feel inferior to other children or different from them. The child should not be deprived of associations and games with playmates. The active child must play. Let it — with glasses. It is especially necessary to encourage healthy outdoor activity in these nearsighted youngsters. In looking after this sort of child a well-rounded diet, good lighting, proper posture, limitation of excessive reading, and avoidance of intensive use of the eyes when tired are all important.

Nor is it too early to attempt to guide the interests of the child toward a career that will not require constant and rigorous use of the eyes. This last suggestion is offered with the knowledge that it is probably not of great practical value. We know from long experience that the nearsighted child is usually of the studious, indoor type and an omnivorous reader. "Elmer's nose is always buried in his book," is a common complaint of the myopic child's mother. These children are much more apt to choose a career that will require life-long intensive application of the eye than a life of outdoor activity. But with proper care and supervision during the growing years this need not be of serious import, as we have already seen.

The cross-eyed child poses a nice psychological as well as ophthalmic problem — one that sometimes taxes the resources of doctor and parent. The most poignantly bitter memories of a lifetime are the moments of tribulation and disappointment of childhood, which in retrospect seem so unimportant. How much more soul-racking, then, is the cross-eye! It fills and

darkens a sensitive child's whole life. The psychic trauma caused by those hateful nicknames of childhood, "squinty" and "cockeye," as well as the actual cosmetic disfigurement and poor vision, may give rise to inferiority complexes that are never outlived and may ruin a bright, otherwise normal child's life.

The old adage "Trust in God but cut the cards yourself" is a good one to follow here. Not for a moment would I disparage faith in the Almighty. But I feel quite certain that a little assistance on our part will not be found displeasing above. We can do much to help such children, mentally as well as visually.

Children with cross-eyes due to poor vision in one eye often have to wear a patch over the good eye. The more this is done, the better for the ultimate result. Many children will wear a patch all day without complaint. Others are extremely sensitive and must be handled gently. The child may be ashamed of its patch, and the careless jeers of other children, even if unintentional, can be very cruel and certainly make the lot of the child no easier. It is sometimes advisable in such cases for the child to wear its patch only at home after school hours. The optimum result may be longer of attainment, but it will save a child much shame and misery.

Sometimes the end is best attained by making a game of it; all parents know how to do that. And they will always find that it is easier and more beneficial to work with the help of a willing child than against resentment. It also facilitates matters if such treatment is made to fit in with the child's normal activities wherever possible. To tell a youngster arbitrarily that he *must* wear glasses or a patch because his eyes are bad will produce less co-operation than if it is explained to the child, for instance, that he will be able to see and play better with the patch or glasses. The difference is subtle but important. Nor does it help a sensitive, squinting child to be constantly reminded of his appearance. Repeated references to his eyes by kind, worried parents will only increase the child's sensitiveness and his feeling of being different and not as good as other children.

This problem is not being exaggerated here, as many parents of cross-eyed children reading these lines well know. The business of training the eyes of a cross-eyed child is a long, tedious process, and parents frequently become impatient before the child does. "How long will Johnny have to wear a patch?" "Will he always have to wear glasses?" Anxious fathers and mothers ask such questions frequently.

There can be no exact answer. The training may require months or, in some instances, even years. If the child's vision is bad he may always have to wear glasses. The parents must decide whether ultimate good vision and straight eyes are worth the trouble. It is often a lot of trouble, and the behavior of the parent is understandable — usually, not always.

A little five-year-old girl had a squint and one almost sightless eye requiring glasses and occlusion of the good eye. After much persuasion the mother finally consented to glasses, but absolutely refused to let her child wear a disfiguring patch; glasses were bad enough. No arguments would budge her. The child had every advantage showered on her. She had elocution lessons, dramatic lessons, music lessons, and dancing lessons. She will grow up accomplished, cross-eyed, blind in one eye, and bitter. The cross-eye may be straightened later, but it will be forever blind. Mother love is wonderful; even more wonderful is ignorant mother love. Fortunately, such extreme cases are rare.

Of much less importance is the color blindness found in one of every twenty boys, much more rare in the female of the species. I spoke earlier of the frequency with which adults are found who have poor vision in one eye without knowing about it. This is even more true of color vision. It sounds impossible, but it is a fact that many moderately color-blind males go through life without knowing of their affliction. It does not bother them, because they simply do not know that it is possible to see colors except as they see them. Those who are more color blind find it out in the high school chemistry laboratory, where they cannot distinguish a color reaction, or when taking an auto driver's test, or in other ways. It

usually helps if the discovery is made earlier in life, before a boy has set his heart on becoming an air-pilot or an artist or something else from which his lack of color sense disqualifies him. Yet, though color blindness may limit a child's choice of a life-career, it is, on the whole, not a very serious handicap. Four to five per cent of all men seem to bear up under it quite well.

It may be of interest to point out here that the Second World War has even found some good in color blindness and has apparently discovered a way to make use of it. There seems to be some evidence that it is an asset in the detection of hostile camouflage. For purposes of concealment, installations in the field are blended wherever possible with the green foliage or the brown-red earth. This type of camouflage seems to be more easily detected by red-green-blind eyes, to which these colors mean little or nothing. In fact, it has been suggested that, where color-blind spotters are not available, tinted lenses that screen out most of the red-green rays be used.

Reading difficulties are frequently encountered among young children. Much study has been devoted in the past ten years to the reading habits of children and adults, and a great deal of interesting material has been turned up. It was found that reading is not a smooth, flowing process, but a series of rapid jumps. The eye stops, takes in a series of about eight or ten letters, and then hops on its way again. So we go skipping from one group of letters to the next. If the text is difficult or uninteresting or in a foreign language, more stops are necessary. Intelligent adults read from three to ten words a second with pauses of one-fifth to one-half second between jumps. The higher the intelligence of the reader, the more rapid the eye movement, and often the fastest readers or "skimmers" get more out of their reading and can reproduce the contents of the reading matter better than the slow reader, despite the latter's more painstaking efforts.

Experienced readers recognize words by their beginnings and take the ends of words for granted. Long or unfamiliar

words, therefore, take longer to read than short ones. It has also been found that we recognize letters by their characteristic upper portion. If you cover the lower half of this line, you will see that there is little difficulty in making out the words. With the obliteration of the upper half of the letters, however, the words become illegible. Reading is therefore not a simple function of vision, light, and education, but a complex of many factors, some of which are not yet clearly understood.

Child educators realize the importance of all these matters, and many improvements have been made in schoolbooks. Legibility of the printed word is important to ease of reading, for a child makes more reading jumps than an adult; i.e., it takes in fewer letters at each stop. The spacing, length of word, type of print, and quality of paper and ink are all to be considered in the choice of literature for children making their initial contact with the printed word.

Estimates of reading difficulties among children run between one and five per cent. In some cases the trouble is due to correctible poor vision or some other ocular disturbance. In many cases, however, the vision is normal, there are no eye muscle deficiencies, and no ocular abnormalities can be found. The child's intelligence may be normal or better. Frequently there is a psychological and emotional problem, tied up with the background and environment of the child. Some of these children are found to be suffering from dyslexia, a high-sounding term meaning inability to read familiar spoken words.

In all these cases child psychologists have not only developed instruments for measuring reading ability, but have also been successful in improving it by newly devised means. These are all situations where the eye physician, the teacher, and the child psychologist must work hand in hand. Mirror writing is a similar though rarer problem, requiring the same co-operative effort. It, too, can be cured by following skilled advice. But all these are problems not within our scope here.

Of more immediate interest to us is the fact that in some of our more progressive school systems the physical surroundings of children are receiving almost as much attention as

their mental instruction. Lighting is arranged to provide adequate glareless illumination that will not tax the eyes beyond their capacity. Seats are so placed that children do not face the bright glare from windows. Desks are so adjusted that posture is correct and strain eliminated from the neck, head, and eyes. These are recent developments, by no means universal, that should arouse the intelligent interest of more parents. Their importance to the optical health and comfort of children is of proved value.

There are also many common diseases of the eye, some mild, others extremely grave, that may affect the visual efficiency of the child.

"Granulated lid" or blepharitis is frequently seen and almost as frequently neglected. This is a red, scaly condition of the lid margins. In extreme cases it may go on to the formation of little ulcers. In the milder early stages it is painless and requires only thorough cleansing of the eye, careful periodic removal of the scaly deposits from the lashes with a wet cotton swab, and the application of a little sulfathiazol ointment (5%) to the lid edges at night. Correction of vision may help. If neglected, this is not an easy condition to eradicate, and the longer treatment is delayed the harder it becomes to clear up completely.

Styes are common and painful. Sometimes they appear in crops like boils. Their familiar frequency should not breed contempt. They too may be the result of refractive errors that have not been corrected. More often they are the signs of a local infection or of a generalized run-down condition or chronic disease. When styes are frequent and untended they may finally cause some distortion of the lids and permanent loss of eyelashes.

On the appearance of a stye the only possible treatment consists of hot compresses applied to the eye three or four times a day for about a half hour each time. These may be of boric acid solution or plain water. A hot-water bottle or an electric pad wrapped in a towel is just as good, because it is the heat that does the work. This treatment is kept up until

the stye softens and "comes to a head." Then it is much better to have it incised than to let it rupture by itself. In this way the recovery period is shortened, and a clean, straight incision will avoid possible irregular healing and permanent scarring due to spontaneous rupture. Unregulated treatment may also tend to spread the infection from one place to another.

The common "pinkeye" or conjunctivitis of children may be a temporary, harmless affection as far as permanent damage to the eye is concerned, but it may also be indicative of a serious disease. In the average mild case the eye usually burns and itches and cannot stand strong light. It is red, watery, usually discharges pus, and as a rule is *not* painful. What is not sufficiently appreciated is that this is always a contagious affair, no matter how painless or harmless.

Almost always it spreads to the fellow eye, and it may be passed on to a whole family or classroom if care is not taken. A child with pinkeye should not be allowed to go to school and should be kept away from other children at home. It should not play with or touch the belongings of other members of the family. After competent medical examination has determined that it is one of the less severe forms of conjunctivitis, treatment is simple and effective. This consists of frequent irrigations, antispetic eye drops, and dark glasses to protect the eye from glare.

A more severe form of pinkeye among children and adolescents is vernal conjunctivitis or spring catarrh. It is a fairly common condition, and the chief symptom is an intense itching. The child will rub the eyes constantly, and this will tend to make them all the more red and teary. After a while the lids become heavy, and strong light becomes unbearable. A thick, viscous white film may be seen under the lids. The vision, as a rule, is not impaired. We are not certain of the cause, but this disease probably falls into the vast group of allergic conditions. It is *not* contagious.

An interesting characteristic of vernal catarrh is that it is present only in warm weather. It will appear in the spring (hence its name), itch the life out of the patient during the

summer, and disappear with the onset of cold weather. In those countries that have warm weather all the time it persists the year round. This has given rise to the belief that the disease is stimulated in some way by strong light, heat, and dust.

The ideal method for curing vernal catarrh is to follow the cold weather. But, as has been pointed out, this is a "counsel of perfection" and is impractical in most cases. Another sure cure is our old ally, time; for vernal catarrh is a self-limiting disease that gradually disappears after five or six seasons, though it may linger longer in some instances. This fact is fortunate, because we have no specific treatment for it. But while waiting for time to do its work the patient can be made more comfortable by medication and treatment to stop the intense itching. Soothing irrigations and protection of the eyes from glare and dust also help. If an investigation uncovers something to which the patient is allergic, removal of this irritative source helps a lot. In any case, most vernal catarrh sufferers will be comforted by knowing that time is on their side.

Trachoma is a much more serious type of pinkeye. The statistics of its prevalence are breath-taking. It is estimated that half the world is infected with it. It is particularly rife around the Mediterranean basin, and in Egypt 100 per cent of the native population suffer with it. That is why trachoma has also been called Egyptian ophthalmia. In countries such as Russia, Poland, and China well over half the population bears its scars. Nor is it by any means uncommon in North and South America, especially the latter.

Until our immigration officials clamped down and made it a cause for non-admission to this country we imported quite a bit of it from foreign sources. It is too bad that these same officials were not on the *qui vive* when Columbus landed, because, according to one belief, his sailors are responsible for its wide prevalence among the American Indians. In some tribes as high as 35 per cent of the members are infected with it. But it is also found in some portions of our native non-

Indian population, especially in a few of our mid-western and southern states and along our seacoasts.

It is a disease associated with dirt and squalor, and it flourishes in crowded, unhygienic surroundings. It is highly contagious, and an individual who is exposed to it, no matter how healthy or how clean, is not immune for long.

Like all other forms of pinkeye, it starts with the eye becoming red and teary and intolerant of strong light. A purulent discharge is common, and soon both eyes are involved. An early typical sign is a drooping of the lids, so that the sufferer looks sleepy. This has been said to be the involuntary cause of the "come hither" look of many Eastern women. This disease is serious because it does not stay put. In over half the cases the cornea also becomes involved; it turns gray and loses its transparency, and vision is either badly impaired or destroyed.

Unless treated early, trachoma leaves ineradicable marks on the eye after it is finally controlled. All over the world there are many adults with distorted lids and poor vision who carry its unmistakable trademark to the end of their days. Treatment of trachoma has always been a puzzle, because of its enigmatic source. The age-old classical remedy, used to this day, is the "blue pencil" or copper sulfate stick, well known and dreaded by many. This is used to "burn off" the products of the trachomatous process from the conjunctiva. In recent years less painful remedies have been brought forth. The sulfonamide group, the latest of these, holds out more hope for those infected with trachoma than we have ever been able to give before.

The sulfonamides have received much publicity lately, and deservedly so. They are undoubtedly the most important new weapon against disease that has come to us in the past few years. The more we use them, the more we realize that there are certain dangers attending their use and certain limitations to their efficacy. They are not the cure-all that popular imagination has built up. Few cures are. The apparently limitless panacea, tested by time and experience, may be found worth-

less or, as in this case, may take its rightful place among the useful medicines of known worth. This is as it should be. A remedy is much more valuable when we know what it cannot do as well as what it can do. This knowledge helps avoid loss of time and useless risks.

Frequently the miracle of yesterday is displaced by the super-miracle of today. It has always been so in medicine. Even now, before we have measured the full potentialities of the sulfonamides, word comes of an even more powerful drug, penicillin, which has proved effective in some cases where the sulfonamides have failed. Both will help us enormously in our fight against disease.

In the early stages of trachoma the sulfonamides are practically always effective. In the moderately advanced stages about 60 per cent can apparently be helped. Only in the final stages of the disease, when the damage is hopelessly final, can nothing be accomplished.

Occasionally a child is seen with a "cold in the eye" that turns out to be a venereal disease. Fortunately the "social diseases" – nothing is more anti-social – may now be discussed openly. This is a good thing, for there is no room here for squeamishness or false modesty.

There are two important venereal diseases that affect the eyes of children: gonorrhea and syphilis. The former is the cause of over 15 per cent of the blindness in this country. In children it attacks the eyes chiefly in the form of a conjunctivitis soon after birth. The visual toll exacted used to be much higher, and would be today if it were not for a German obstetrician named Karl Siegmund Franz Credé. He is responsible for saving many a newborn infant's eye.

Conjunctivitis of the newborn (ophthalmia neonatorum) has been known for centuries. Long ago the ancients realized that there was something in babies' eyes capable of causing blindness soon after birth, and this started the useless custom of dropping oil into the eyes of the newly born child. It was not until 1880, when Credé described his method of treating the eyes of the newborn, that we had an effective method to combat this scourge. The treatment consists of carefully wash-

ing the eyes of the infant immediately after birth and instilling a one- or two-per-cent solution of silver nitrate into each eye. So effective has the Credé treatment proved that many now agree that "ophthalmia neonatorum is a preventable disease occurring in the newborn as the result of carelessness at the time of birth."

Many states in this country and many countries all over the world have passed laws making the Credé method compulsory. But despite all these laws a certain percentage of babies continue to contract the disease at birth. Unequal laws and lack of enforcement are partially responsible. Ignorance and carelessness help.

The disease is acquired by the infant as it passes through the birth canal of the mother. Sometimes it is due to unclean handling soon after birth. From its onset it can be recognized by a redness and swelling of the lids and a thin, watery discharge from the eyes, which rapidly becomes thick and purulent. The dangerous consideration, here also, is that when neglected it affects the cornea and impairs vision. It is highly contagious. Once developed, it is a serious problem, requiring constant nursing attention and, better, hospitalization.

This disease, though usually venereal in origin, is not always gonorrheal. Authorities are not agreed as to actual percentages, but some believe that only half the cases of conjunctivitis of the newborn are due to gonorrhea. Hence the stigma of a social disease need not attach to the infection of the infant. Where it is due to gonorrhea, however, and loss of vision results, the parents are just as responsible for the child's blindness as if they had deliberately poked out its eye. Parents who do not want to transmit their disease to their offspring should be careful that they are medically clean before they marry. A gonorrheal infection acquired before marriage can be cured by proper medical care. Even if it is transmitted, the danger to the child's eyes may be averted by prompt treatment before and directly after birth.

The other venereal disease, syphilis, is in many ways a more serious menace, because the damage it does is more difficult to control, and also because it is always a generalized

bodily disease of which the eye symptoms are only one manifestation. It is responsible for over 10 per cent of the blindness among adults. In children it may show itself soon after birth, or it may wait until adolescence and then, without the slightest warning, it may strike down an innocent child who is apparently quite normal and healthy. A blood test soon reveals the cause. The shock of the revelation to an unsuspecting high school boy or girl who has acquired syphilis from the parents cannot be easily described or imagined. The situation, never pleasant, is often tragic. In at least one case, very little kept a youth from patricide.

Congenital syphilis of the eye most often manifests itself as a painful redness with clouding of the cornea. During the height of the attack vision may be reduced to bare light perception; and even after the eye recovers, permanent visual loss of greater or less degree is often the result.

This also is a preventable disease, donated gratuitously by parents to offspring. Proper medical advice and treatment of infected parents can assure a healthy baby. Treatment given an expectant mother who is syphilitic can be effective in preventing infection of the child to be born. Occasionally it happens that the mother contracts the disease from a taciturn father and is ignorant of the fact that she has syphilis; such cases are not unknown. Those states that now require a blood test as a prerequisite to a marriage license are the means of sparing us many a blind eye in children.

It is impossible to describe or to list all the eye diseases of childhood here. But this is the logical place to state flatly that there is no such thing as a "cold in the eye." That is a careless euphemism that has been applied to every one of the above conditions and a host of others. A red eye, with or without pain, is usually an infected eye and may be a source of danger, not only to its fellow eye, but also to the eyes of fellow beings. A red eye, with or without pain, that does not show improvement in a day or so needs medical attention.

I urge prompt care in all such cases, not because all children's eye diseases are serious – on the contrary, most of them are simple and respond encouragingly to treatment –

but because the parent has no way of distinguishing the mild from the severe cases, the contagious from the non-transmissible. Many of these diseases of the eye start in the same way, with redness, tearing and fear of light, and little or no pain. A trachoma, a vernal catarrh, an eczema of the conjunctiva or cornea, a serious corneal ulcer, a severe internal eye disease, or even an unnoticed cinder of the cornea will get home treatment for days before the doctor sees it. By that time a lot of damage, often irreparable, is done.

Another reason for medical advice is that even some of the milder eye affections may be indicative of general disease or deficiency, such as malnutrition, poor hygiene, improper diet, etc., and would benefit by proper general treatment as well as local eye treatment.

What was said previously about the hygiene of eyes in general is also applicable here. The normal child's eyes require little fussing. Do not use drops or washes on an infant unless they are ordered by the attending physician. Protect an infant's eyes from strong light and glare when outdoors; face the child away from the direct rays of the sun. Darkening a room completely when a baby is sleeping indoors is unnecessary, even in the case of a sick baby.

There used to be a mistaken belief that a child with measles, for instance, must be kept in a completely darkened room. Light, the villain, was supposed to do dire things to the eyes of children with measles if allowed to enter. The basis for this superstition is the fact that in measles there is usually an attendant pinkeye. As in all cases of pinkeye, the patient is more comfortable when the light is not too strong. This means a room with subdued light or dark glasses. It does not mean a room so dark that you go around stumbling into things in caring for the child. And, when convalescing, a child should not be allowed too much use of the weakened eyes until complete recovery.

Children with poor vision due to congenital defects or due to diseases of the early years may be saved an unhappy, ignorant life by receiving education in sight-conservation classes. These provide special books with large type and ac-

cent oral education in order to save the vision of poor eyes as much as possible. One or two children in every thousand will have a vision of 20/70 or less in the *better* eye, and these are eligible for the sight-saving school. Quite a number of these schools are scattered throughout the country, and they are a godsend to the dim of vision.

For those children with vision of less than 20/200 in the better eye, vocational training and Braille classes are available in the blind schools of all large centers of population. About half the blindness of children in schools for the blind is due to accidents at birth or to heredity. The other half become blind in the first few years of life.

Such organizations as the National Society for the Prevention of Blindness and the various State Associations for the Blind do much to ease the lot of these blind and semi-blind youngsters. They have never received full recognition for the good they do and for the light they bring into young lives. They do much in the field of sight conservation and in educating the public to the dangers of neglect of eye care in health and disease. This work goes on unabated, and the need for it has no end.

Finally, something about children's toys. No chapter on children's eyes can be complete without a plea for sane toys for children. Toys are the immemorial birthright of children, but they should not be dangerous, destructive weapons. Sight-destroying fireworks have been banned in many communities, but darts, arrows, BB guns, and slingshots take their toll of children's eyes annually. "Cowboys and Indians" and "cops and robbers" deprived of these lethal instruments would be tamer affairs, but vision would be much safer. Careful parents will not allow their children to play with such toys. It would be far better if they were not manufactured to tempt and destroy the eyes of children.

To sum up, then: Routine eye examinations of all children at three, seven and twelve — oftener if necessary — are important to assure visual efficiency. In case of need, prompt,

skilled care is surest and safest. And it is well to keep in mind, also, that we are not dealing with a child's eyes, but with the eyes of a child — an individual whose eyes are only part of a complicated human whole. The eyes may affect the child's whole physical, mental, and nervous status, and treatment is most successful when the owner along with the eyes receives thoughtful consideration.

XV

The Adult and Old Eye

In childhood our chief interest is in visual preparation, in priming the eyes to their highest efficiency for the long road ahead. In later life we are more concerned with conservation, with preserving good eyesight despite the natural deteriorative processes that attack all parts of the aging human machine, including the eye.

As we grow older we tend to grow smaller. Rich living may pad our haunches and swell our paunches, but all the important body tissues and organs shrivel and shrink. The skin wrinkles and sags because the underlying tissues waste away. The muscles wither and lose their resiliency. The bones become thinned, brittle, and atrophic. The whole body becomes contracted and bowed. Many of these changes do not become apparent until late in life. They are slow and gradual, but they are certain.

There is one outstanding exception to this general bodily dwindling: the crystalline lens of the eye. From the moment of birth to the moment of death it continues to grow and expand. It ages, not by shrinking, but by growing hard and inelastic. And this fact is answerable for our loss of accommodation, our gradually decreasing ability to focus on near objects after the age of forty. This old sight or presbyopia is a universal age-process; it is as natural as growing old is natural, and for most of us it constitutes the sole visual hostage to a ripe old age.

A more obvious and much less important sign of multiplying years in the eye is the corneal arcus senilis, or senile ring. This is a grayish-white circle that forms at the edge of the cornea and decorates many an old eye. Rarely, it is seen in younger eyes. Often it is an unnecessary source of apprehen-

sion; it has been mistaken for a cataract. It is absolutely harmless and has no effect on vision. It is simply a visible footprint of the march of time over us.

Some of us, however, do not escape so easily. As we take our rightful places in the ranks of middle age we also become subject to some of its penalties, and a certain number of us inevitably acquire some of the diseases of the middle-aged and old eye. For, whereas most of man's ocular ills have no respect for his years, whether few or many, some are typical of the later years. The two most important of these are cataract and glaucoma.

These two diseases plague us more and more as the proportion of people over the age of fifty increases. In 1890 the average life expectancy was only forty. In 1940 we can look forward, on the average, to a life span of sixty-two. In this country almost one-third of the population is over fifty now, and 8 per cent over sixty-five. The vast majority of cataract and glaucoma cases occur after the forty-fourth year, and statistics show that between 1890 and 1920 glaucoma became multiplied by nine, and cataract proportionately. Both have undoubtedly increased since then, and they continue to increase as more and more of us live long enough to enter the ages at which cataract and glaucoma are most common.

The word "cataract" has on many people the soothing effect of a sudden pinprick. The whole subject is surrounded by an umbra of superstition and a penumbra of fear that are hard to penetrate. To a large extent the fear is unjustified. Some of the anxiety could easily be spared for glaucoma, which is far worthier of fear, but less known.

Cataract is *not* a form of cancer and has no relation to cancer. Neither is it a film that grows over the front of the eye, as many seem to think. It is a clouding of the crystalline lens inside the eye. Instead of remaining normally transparent, the lens becomes opaque, like ground glass, and details of objects are no longer visible through it. This is always a painless process unless it is associated with some other disease.

Infants are sometimes born with such cloudy lenses; we call these congenital cataracts. In adult life injuries and diseases

of the eye may cause the lens to become opaque. But by far the most common type of cataract is that which comes with age, and which for want of a better name we call simply senile cataract. The hard fact is that with the exception of cataracts due to birth accidents, to injury later in life, and to a few well-known diseases, we really cannot account for most cataracts. If we leave off all the scientific furbelows, we can ascribe them to the aging process itself. We have learned how to become older, but not how to escape some of the unpleasant accompaniments of longevity or why we suffer them.

Neither can we explain why some get cataracts and others do not. Age is a well-known disease that all of us acquire with the years: yet many an octogenarian retains clear vision and eyes far younger than his years. Sometimes cataracts run in families, but this is not a hard-and-fast rule. If your father or mother had cataracts, that does not mean that you have to get them.

A fair proportion of cataracts never reach maturity or become sufficiently dense to destroy useful vision. The lens may start turning a grayish or brownish color, and the patient will notice that his vision is getting worse. But instead of going on to complete obscurity of vision, the process may stop at any time and never get any worse. Someone gets the credit for "curing" these cataracts sometimes. But there is not a cure; there is simply a cessation of the cataractous process, and it occurs in spite of anything we do or do not do. That is why a doctor will not operate on a cataract until there is a marked impairment of vision. As a matter of fact, most people over sixty, if carefully examined, will show some senile changes of the lens that do not affect vision. In some of these, however, the normal senile changes continue to the point of mature cataract formation.

Occasionally the first stage of a beginning cataract is an acceleration of the normal process of change in lens size and structure, without much loss of transparency. The lens grows so rapidly and becomes so thick that it becomes a more powerful focusing apparatus. This accounts for the "second sight"

of a few people who joyfully lay aside their glasses late in life. But this is one of nature's sadder little jokes, and the rejoicing is always premature. The lens goes on from there to become opaque and to form a cataract.

We know of no sure medical method to cure a cataract or to make it disappear with "drops." Much experimental work is being done on this subject, and it is not impossible that at some future date we shall know what causes this senile impediment to vision and how to cure it. At present, however, we can do little about stopping it once it begins to develop. To be candid, we do not even know how to stop it from starting. But while we cannot restore the lens to its original transparency, we can restore vision to the eye.

Cataract is not an incurable disease. Nor is there any reason for curtailing all visual activity just because an early cataract is beginning to form. Reasonable use of the eye does not hasten cataract formation and is perfectly permissible.

Once a cataract has formed, the only sure method for its treatment now at our disposal is surgical removal. This is a serious prospect, of course, but it should not be a frightening one. If the patient's general health is reasonably good, age, even advanced age, is no bar to operation. The removal of a cataract is usually done under local anesthesia, and there is little surgical shock or severe after-effect. Following cataract extraction and proper correction with glasses, good vision is the usual rule.

There used to be a time when the patient had to wait around, long after he was completely incapacitated visually, for the cataract to "ripen." With our modern operative methods this is no longer necessary. It is now possible to remove cataracts successfully as soon as they have developed to a point where the loss of vision is a handicap to the business of living.

And right here I must prick another bubble of misconception. The cataract operation itself is not enough to restore complete vision. All that it does is to remove the opaque lens, thus allowing the light to get unhindered into the eye again.

But in order to be able to focus the light on the retina and to see clearly the patient must wear a lens in front of the eye, to replace the one removed.

These lenses are often thick and heavy. Furthermore, they are made of glass, a hard, inelastic substance that inevitably gives a static kind of vision and not the easily adjustable, elastic vision of the normal eye. Those who expect, by having their cataracts removed, to have their vision restored to its pristine youthful state will be disappointed. It is sad, but there is a limit to human ingenuity. We can make the eye see again, but it is not the same eye any more, nor the same kind of vision. On the other hand, most patients are so overjoyed at having their sight restored that they quickly adapt themselves to their new vision and carry on their business and social activities exactly as before.

In short, then: Cataracts are by no means the frightening, horrible things that many believe them to be. We can do little about stopping their progress, but we can do much to restore good vision after they have developed, and blindness due to cataract need not be permanent.

How different is the story of glaucoma! We can do much to mitigate its ravages in the early stages, but once it is fully developed little can be done. About 15 per cent of the blind in this country — blind in both eyes — are sightless because of glaucoma. Many, many more, thanks to glaucoma, have little vision in one or both eyes, not amounting to total blindness. A great many of the anonymous eye troubles of public figures in the news are of glaucomatous origin.

Stop the average man in the street, and he will enlarge with gusto on the horrors of cataract. He will know many a gruesome detail, and from his vast fund of inexperience he will shake his head in dark — and hazy — foreboding at the suggestion that cataract can be cured. Of glaucoma he has never heard.

Just why this should be I cannot say. Glaucoma is certainly not a new disease. Its very name is derived from the ancient Greek word meaning bluish-green, which describes the appearance of the cornea during an attack of acute glaucoma.

The old-timers, it is true, did not know too much about it, and they certainly knew nothing of its causes. But that is hardly strange: we know little about that today. They did, however, leave us descriptions of its effects, and we know these only too well.

Glaucoma is one of the most important and least known causes of blindness in civilized countries. It creates more sightlessness than the more highly publicized syphilis. It is primarily a disease of late middle age, and the main symptom is a hardening of the eyeball of greater or less degree. It manifests itself in two distinct forms.

It may come on in a sudden and acute manner, with the eye becoming stony hard, red, and excruciatingly painful, and the vision rapidly reduced to bare perception of light. This may occur in an eye that has always been apparently healthy, or it may happen to an eye that has been suffering with the chronic form of the disease for a long time. The patient will seek medical aid at once. He is driven to it.

But much more often it comes insidiously and robs us of our vision stealthily, without our suspecting it. This is its most common guise, called chronic glaucoma, and its manifestations may be so well hidden that it has got a firm foothold before it is discovered. If there are symptoms, they may be so unobtrusive that a healthy, active, ordinarily unobservant individual will pay little attention to them or ignore them as temporary and unimportant until too late. Some of these vague, early danger signals to be watched for are:

Occasional headaches coming on during and after sleep, after the movies, and under all other conditions of dim illumination. (They may come on at any other time, also.)

The necessity for an unusually frequent change of glasses, especially reading glasses, and a rapid loss of ability to read, write, and do work at close range.

A gradual loss of peripheral vision. This is especially hard to notice, because, since we have binocular vision, the sight of our two eyes overlaps, and one eye can make up for the deficiency of the other for a long time. Vision in one eye may be so far gone that a person with chronic glaucoma cannot see

an automobile coming at him from the side until it is almost on top of him. Such an individual, if he is fortunate, may happen to close his good eye some fine day and suddenly become aware of his visual loss in the affected eye. If less lucky, he may need a serious accident to bring it home to him.

Some persons have been known to have an advanced degree of peripheral loss of vision in both eyes without noticing it. This is explained by the fact that central or straight-ahead vision remains fairly good until late in the disease. In the end such a patient has what is called "tubular vision" only, as if he were constantly looking through a double-barreled shotgun. Try looking through two long, narrow tubes of paper pointing straight ahead, and note how little you can see to the side and the tremendous handicap to normal movement that this confinement of vision causes. Even the most unobservant notice the process before it has reached this last stage.

Ultimately, of course, straight-ahead vision also becomes impaired, but by the time this happens so much ineradicable damage has been done that it is much too late to do anything for the eye.

Sometimes there are transient spells of blurred vision that pass quickly. There may be an occasional twinge of pain, or a slight unexplained redness of the eye may be noticed once in a while. An extremely important warning signal is the appearance of colored halos around lights. This may be the only advance notice of an attack of acute glaucoma. All, some, or any one of these may appear with little or no actual pain.

Or not one of these symptoms may be present or noticed while painlessly and secretly — unless the individual is unusually observant — first peripheral vision and then central vision are slowly destroyed. Glaucoma has been well named the "death of vision." It is astonishing how often the first inkling a person has of glaucoma is when he comes to the eye physician for a routine examination. I have said this before about other eye disturbances, but it is most tragic here.

Hence, though acute glaucoma is a good deal more painful and requires more immediately energetic treatment than cat-

aract, it may ultimately prove less dangerous to useful vision, because it gets immediate attention. At least there is a definite warning and a chance to get help.

Despite almost a hundred years of intensive research we are still in the dark as to the important underlying reason or reasons for the appearance of glaucoma. A few we know. One important cause is certainly the increase in the size of the lens. It may swell so rapidly that it simply becomes too big for the eye. Since the lens is encased in an envelope of fibrous inelastic tissue, the pressure in the eye must go up. It is as if more air were being forced into an already hard football. Another cause is some injury or disease that has caused the lens to swell or has interfered with the orderly arrangement of structures and normal processes of circulation inside the eye. These are all secondary glaucomas; that is, secondary to some known cause.

But such considerations, though they explain some cases, do not help us with the vast majority of primary glaucomas (we call them primary when we do not know the cause), in which there is no lens swelling, no apparent disease, and no history of injury. Nor is there a complete answer to the puzzle of why some eyes with swollen lenses do not develop glaucoma.

We have, however, learned a great deal. We know, for instance, that glaucoma is more likely to occur in the excitable, highstrung individual than in the calm, non-worrying type. There is a frequent history of a glaucomatous attack being preceded by a severe nervous shock or bad news of some kind. Oddly enough, sudden good news may also bring it on. We know that glaucoma occurs much more often in the relatively small farsighted eye than in the relatively large nearsighted one. On the whole, it is more common in women than in men, and it occurs more frequently in winter than in summer. It has also been known to recur in several generations of one family, but here again, as in cataract, the hereditary tendency is neither definite nor inevitable.

I have said that we freely admit our ignorance of the basic causes of glaucoma. This lack of knowledge hampers us in

our treatment, because it precludes the possibility of a specific cure such as insulin for diabetes, salvarsan for syphilis, or quinine for malaria. But even with our modicum of knowledge we do know that if glaucoma is diagnosed and treated in its *early stages* an eye may be saved that will otherwise surely become blind. This is all the more important because glaucoma, both acute and chronic, though it usually affects only one eye at first, always attacks both eyes sooner or later. It is a binocular disease.

The importance of early diagnosis may be judged from the statements of competent authorities that 90 per cent of those now blind from glaucoma could have been saved had they been treated early enough. A regular medical eye examination, if it does nothing but catch and check an early glaucoma, is well worth all the trouble it costs.

Of what does the treatment consist? In the milder cases, medication and a prescribed hygienic regimen may keep the disease from advancing. In progressive and severe cases, operation is always necessary. Our arts are not always successful here, but, on the other hand, glaucoma left to its own devices means inevitable blindness.

The Committee on Glaucoma of the National Society for the Prevention of Blindness has issued the following rules for glaucoma patients:

1. Carefully follow your eye physician's instructions, and remember especially to return for re-examination at the appointed time.

2. Consult him at once if you see rainbow-colored halos around lights, if the eye becomes painful, or the vision is blurred, or sight impaired in any way at all.

3. Avoid as much as possible excitement, anger, worry, fear, or disappointment.

4. Take care that bowel movements are regular.

5. Avoid tight-fitting clothes—especially a tight collar, corset, or belt.

6. Keep your blood circulation active. If occupation compels you to sit the entire day, take a long but not too tiring walk before and after work.

7. Keep your teeth clean and healthy; pay attention to acute or chronic colds.

8. Limit drinking coffee and tea (not too strong) to one cup a day. Avoid alcoholic drinks.

9. Keep bedroom well ventilated and at a moderate temperature; around 70 degrees (Fahrenheit).

10. Avoid dark rooms as much as possible. Go to movies only if your eye physician permits. Remain at the movies for only one feature and, if possible, choose subjects that are not depressing or upsetting to you.

11. Do not use any drops or eyewashes without consulting your eye physician. They may be very harmful.

12. Have a periodic (yearly) examination of your entire body by your family physician.

These rules are for persons who already have glaucoma, but the fact that they need publicizing proves how little of the grave import of the disease has penetrated the public consciousness, even the consciousness of those who have and know that they have the disease. This table of rules is presented here because it emphasizes what has been said above. Note that, in addition to personal hygiene, it lays stress on the avoidance of excitement, stimulants, and dimly lighted rooms. And mark especially the importance of reporting the appearance of rainbow-colored halos around lights.

At best the diagnosis of an early transient glaucoma is not simple, and a possible patient may do himself a great service if he knows something of the symptoms and reports them immediately to his physician. A suspicious story will institute investigation and treatment that may save vision. Even if the alarm is false, no harm has been done, and this seems to be one place where a little unnecessary alarm is justified. Good medical practice, unlike legal, requires that the suspected adult eye be considered guilty of glaucoma until proved innocent.

The adult eye has other visual enemies to guard against. The older eye is subject to the various external and internal infectious diseases that attack the younger eye. Styes, pink-

eye, ulcers of the cornea, inflammations of the iris, and diseases of the retina are constantly seen. The venereal infections are particularly prominent among the younger adults.

What has been said about the dangers of gonorrheal conjunctivitis of the newborn is just as true of the adult, and even more true. This disease is much more severe and damaging in the older individual, and until the advent of the sulfonamides one in every five gonorrheal infections of the eye resulted in blindness. It is still nothing to be trifled with. Its acquisition and spread are by direct contact, usually sexual, and are due to uncleanliness and carelessness.

Gonorrhea is one of the aristocrats of the diseases of the animal kingdom. It is the exclusive property of man and the higher apes; repeated attempts to inoculate lower animals with it have failed. (Here is something on which the fundamentalists can ponder.) Recent publicity given the venereal infections by the U. S. Public Health Service has cut into the thriving trade of some druggists and many quacks. But not enough. Sub-rosa and unskilled treatment is responsible for many of the worst complications and after-effects of gonorrhea of the eye.

Another danger is that partial and false cures may lull the patient into a false sense of security from which the awakening is exceedingly rude. The apparently cured disease can lie dormant for a long time and may manifest itself long afterward by the infection of an innocent mother and baby. The only safe procedure is to avoid self-, lay, and quack medication. Treatment is available to all. For those who cannot afford private care, city health services generally supply free venereal treatment. The disease is much too widespread, and more publicity and public education are in order if we are to make more headway against the eye mortality resulting from it.

Syphilis of the adult is a much more widely disseminated disease than gonorrhea. Reports published by the American Social Hygiene Association tend to show that one in every twenty of our whole population has syphilis. The exact figures are a subject of debate, but we do know that syphilis is

about fifty times as common as tuberculosis. Some population groups, of course, are much more heavily infected than others, but the disease is sufficiently prevalent even among the "higher classes."

Acquired syphilis is a generalized disease; it attacks all the tissues of the body and all parts of the eye. The cornea, the iris, the retina, the optic nerve, and the eye muscles may all be involved. Particularly to be dreaded are the syphilitic degenerations of the retina and atrophy of the optic nerve, both leading to ultimate visual destruction and both irreversible. Here again prompt early treatment obviates the more serious complications and saves vision.

In addition to the venereal infections, accidents and injuries to the eye are common in the twenties and thirties, since this is the most active time of life. Industrial hazards are the most important single cause of blindness in this country. They still constitute a serious problem for the industrial safety engineer, despite the progress already made in this field in recent years. Industry pays out $50,000,000 a year in compensation claims alone. A good share of this is for injuries of the eye. In many cases the payment does not begin to compensate the injured worker for the monetary loss in time, wages, and ultimate earning power, to say nothing of the considerations for which money cannot pay. The exact value of an eye to a man has never been accurately calculated, and industry itself needlessly loses many skilled workers every year. Many of these accidents are due directly to the failure of workers to make use of goggles and other safety devices provided for them.

Blows to the eye, in industry and out, are one of the main causes of a less common visual disturbance of the adult — not necessarily old — eye: namely, detachment of the retina, resulting in the sudden loss of vision in an eye.

I have shown that the chief function of the eye is to support and nourish the retina, the most important of its structures. Fundamentally, all blindness is due either to disturbances in the retina itself, in the retinal connections with the brain, or in the structures in front of the retina that

may prevent light from getting to it. The retina is therefore the central governing station of the visual circuit, and any kind of damage to it interferes with the process of vision.

The retina is the inside lining of the eye, except in front where the cornea makes a window to let the light in. Now, the retina is not fastened to the inside of the eye, but is held in place by the pressure of the contents of the eye. To use a previous example, it is like the rubber lining inside a football, which is held in place by air pressure; only in the eye it is the transparent jellylike vitreous body that fills the eye and keeps the retina in place. Considering the jars to which we and our eyes are constantly being subjected, it is remarkable that the retina does not become detached more often.

A second important cause of retinal detachment is nearsightedness. In high myopia, not only is the eyeball markedly elongated, but this extreme stretching interferes with the normal metabolic processes that nourish the internal ocular structures and keep them healthy. As a result the vitreous jelly loses its firm consistency and becomes more fluid. The retina, losing this support and becoming degenerated on its own account, is dislodged from its normal position, and suddenly the patient is aware of a painless loss of vision.

A third equally common cause is no known cause. The eye is not nearsighted, and it has sustained no injury; but one minute the patient has normal vision and the next he has none, and the most exhaustive search discloses no apparent cause for the detachment. It is pretty generally agreed now that this does not happen in an entirely healthy eye — that such an eye is abnormal in some way. But in what way, we do not know. Here is another puzzle to add to our long list of conundrums requiring solution. Occasionally the mishap does not come out of a clear sky: the victim may be forewarned by seeing spots and light flashes for some time before the retina becomes separated.

Other less frequent but known causes of retinal detachment are tumors, inflammations, and other diseases of the internal eye tissues that cause a disturbance in the normal ar-

rangement of the inner eye structures and interfere with the integrity of the retina.

Detachment of the retina from its normal position can now be seen and diagnosed, even if the displacement is not great. This advance we owe to Helmholtz, who not only gave us our most plausible color theory, but also invented the far more practical ophthalmoscope, which enables us to look into the eye. It is with this little instrument that we detect many of the general bodily and intrinsic eye diseases that have been mentioned earlier.

The ophthalmoscope is an extremely simple instrument. Essentially it is merely a little mirror with a hole in the middle. The mirror directs light into the eye, and the examiner follows the path of light through the little central opening and inspects the internal tissues that are lighted up. The ophthalmoscope is not hard to use: the important thing is to be able to interpret what is seen. With this simple little invention, in 1851, ophthalmology took its longest stride forward. For the first time that hitherto dark, mysterious cavern, the inside of the eye, became an open book. Many of the internal lesions and diseases of the eye that were formerly only guessed at could now be seen, estimated, and interpreted. Many suspected causes of blindness, and many hitherto unsuspected, became the certain common knowledge of the physician.

Despite the fact that we have known about retinal detachment for a long time, it is only in the past fifteen years that an adequate operative technique has been perfected for it. There is now a delicate operation by which, in a fair proportion of cases, the retina may be fastened back in place and useful vision restored, if the operation is done soon enough. Like many other diseases of the eye, retinal detachment, unless due to a blow, occurs without pain. Hence in all cases of sudden, painless diminution of vision this is one of the important causes to keep in mind.

And while we are speaking of recent developments in the field of eye surgery, we must say a few words about the corneal transplant. This is the operation by which a small window is cut in an opaque cornea and replaced by a piece of

clear cornea. In the past few years nothing about the eye, with the possible exception of the contact lens, has received more publicity. And nothing has raised more false hopes. To many misinformed men and women it seemed that the millennium had come and that a hopelessly bad eye could now be traded in for a good one. Nothing is farther from the truth. It should be known that this operation is on the *cornea only*. It can be performed only in those cases where the cornea, by reason of injury or disease, has lost its transparency or its regularity, so that vision is impaired. It can be successful only in those eyes that are healthy except for an unclear cornea. Obviously, there is no earthly use in giving the eye a clear window if there is something else inside the eye that prevents it from seeing. And even under the best circumstances the new corneal window may become opaque again. Why, we do not know.

The corneal transplant operation is an incalculably important advance in eye surgery. It is the result of many years of experimentation and research. It has restored vision to many eyes that would otherwise be blind. But it is far from being a universal, indiscriminate panacea. We have edged a step nearer the goal of restoring vision to blind eyes, but the goal itself is still far ahead of us. The widespread notion that with this operation an entire diseased eye can be removed and a new one put in its place is wrong. That little bit of magic is still a trifle beyond us.

The pages of this book are liberally sprinkled with confessions of ignorance. Phrases such as "we do not know" and "the cause is obscure" occur frequently. But that should not discourage us or make us despondent. It is true that there are many still baffling enigmas connected with the eye. On the other hand, we have progressed immeasurably in the past fifty years. Many today carry on normal, useful, seeing lives who would have been hopelessly sightless fifty, twenty-five, or even ten years ago. With more co-operation from the eye owner even more could be done.

Patients – not all of them, fortunately – will sometimes ex-

pect the impossible after having caused all the damage possible. There is an old story about a man who, when asked by the doctor to state his trouble, replied challengingly: "You tell me; you're the doctor." The implication is obvious. The doctor is a physician, not a magician. He can only help the patient when the latter is anxious to help himself.

You cannot make two good eyes grow where two bad ones always grew before. And an eye ravaged by disease and dimmed by neglect is an irreversible chemical reaction in most cases. It is not possible to throw this eye back into the pot and take out a nice, shiny new one. It is much better to use the oft-invoked but little-used ounce of prevention. Use two ounces if necessary. It pays.

The foregoing sentiments sound, I know, rather trite. But their commonplaceness has not made them universally accepted codes of conduct. Far from it. Many, if they think of these things at all, do so quite abstractly and impersonally. Almost every man will tell you that he knows all about preventive medicine. He will aver with the utmost sincerity that he is a thorough believer in the principle of throttling disease at its source. Yes, sir, a darn good thing, too! But he will wait until he is half blind before he sees a doctor about his eyes. Ask any physician.

Within the past few years a good deal has been said about doctors and medical service. The future will decide who is to pay for our ill health. Our interest here is in good health. That includes the eye. We human beings regard good health as our God-given prerogative. We resent illness as an infringement of our inviolable rights. This is an illusion. Good health today is the result of man's work and knowledge and ingenuity. The privilege of keeping it is paid for by constant vigilance.

You who have followed me to the bitter end have learned long ago that the constantly repeated burden of my song is this: Ailing eyes should receive prompt and competent attention. The tune has probably become monotonous by this time, but the words are still accurate. "The light of the body is the eye" was said two thousand years ago, and it is just as true today. Don't let your light grow dim.

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TYPE NOTE

The text of this book is set in Caledonia, a Linotype face which belongs to the family of printing types called "modern face" by printers – a term used to mark the change in style of type-letters that occurred about 1800. Caledonia borders on the general design of Scotch Modern, but is more freely drawn than that letter.

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